

A Report of the 24th Northeast Regional Stock Assessment Workshop

**Assessment of the Gulf of Maine
Atlantic Cod Stock for 1997**

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An alternative stock assessment analysis for Gulf of Maine Atlantic cod

Assessment of the Georges Bank Atlantic cod stock for 1997

Assessment of the Gulf of Maine Atlantic cod stock for 1997

Assessment of the Southern New England yellowtail flounder stock for 1997

Evaluation of vessel logbook data for discard and catch-per-unit-of-effort (CPUE) estimates

Proration of 1994-96 commercial landings of Atlantic cod, haddock, and yellowtail flounder

Report of the 24th Northeast Regional Stock Assessment Workshop (24th SAW): Public Review Workshop

Report of the 24th Northeast Regional Stock Assessment Workshop (24th SAW): Stock Assessment Review Committee (SARC) consensus summary of assessments

Stock assessment of Georges Bank yellowtail flounder for 1997

Ten-year projections of landings, spawning stock biomass, and recruitment for the five groundfish stocks considered at the 24th Northeast Regional Stock Assessment Workshop (24th SAW)

U.S. assessment of the Georges Bank haddock stock, 1997

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ABSTRACT

The status of the Gulf of Maine cod (*Gadus morhua*) stock is reviewed and estimates of 1996 fishing mortality and 1997 stock size and spawning stock biomass are presented. Precision of the 1996 fishing mortality and spawning stock biomass estimates, and a retrospective analysis of the performance of the VPA for Gulf of Maine cod are also provided. Short-term projections of 1998 landings and resulting 1999 spawning stock biomass at various levels of 1998 fishing mortality are also given. The 1997 assessment was based on several sources of information including: USA landings at age estimates, Northeast Fisheries Science Center (NEFSC) and Massachusetts Division of Marine Fisheries (DMF) spring and autumn research vessel survey data, NEFSC Sea Sample data, and standardized USA commercial fishing effort data.

This assessment extends and expands the analyses presented in the previous assessment of the Gulf of Maine cod stock (Mayo 1995). The major revisions are:

1. Commercial landings from 1994 through 1996 were derived from mandatory dealer reports prorated to stock using mandatory Vessel Trip Report (VTR) data.
2. Discards of Gulf of Maine cod from 1989 through 1996 were estimated using NEFSC Sea Sample data for otter trawl, shrimp trawl and gillnet gear.
3. Catch at age of Gulf of Maine cod taken in the recreational fishery from 1982 through 1996 were estimated using MRFSS catch and biological sample data.
4. Commercial landings per unit effort (LPUE) indices and standardized fishing effort were re-estimated from 1982 through 1993 using commercial interview data.
5. Commercial landings per unit effort (LPUE) indices and standardized fishing effort were estimated from 1994 through 1996 using commercial vessel trip report data.
6. The influence of the commercial LPUE at age index in the most recent 3 years (1994-1996) was removed from the VPA calibration because the VTR-based effort estimates were considered uncertain.

Total landings of Gulf of Maine cod equalled 7,194 metric tons (mt) in 1996, a 6% increase over 1995 (6,798 mt). Landings from this stock were 8,287 and 7,877 mt, respectively in 1993 and 1994. Commercial landings per unit of standardized effort declined steadily between 1982 and 1987, increased during 1988-1990 but declined sharply in 1992 and remained low in 1993. Fishery-independent spring and autumn bottom trawl surveys conducted by the Northeast Fisheries Science Center have documented a steady decline in total stock biomass since the 1960s; the largest decreases occurred during the 1980s. The 1995 and 1996 indices suggest that the Gulf of Maine cod stock remains at a record-low biomass level. Except for the 1992 year class, recent recruitment has been well below levels observed prior to the 1980s; recruitment prospects for the 1994 and 1995 year classes are extremely poor.

Spawning stock biomass declined from over 26,000 mt in 1989 to a record low of 8,600 mt in 1994, with only a slight increase to 9,200 mt in 1996. At the present level of exploitation and, given the probable level of recruitment in the near term, the decline in spawning stock biomass is expected to continue. Fishing mortality has remained at or near 1.0 since 1983, resulting in an exploitation rate of about 58%. If this level of exploitation continues, commercial landings are projected to decline to less than 4,000 mt in 1998 and spawning stock biomass is projected to decline to about 4,300 mt in 1999.

INTRODUCTION

Atlantic cod (*Gadus morhua*) in the Gulf of Maine region have been commercially exploited since the 17th century, and reliable landings statistics are available since 1893. Historically, the Gulf of Maine fishery can be separated into four periods (Figure 1): (1) an early era from 1893-1915 in which record-high landings (> 17,000 mt) in 1895 and 1906 were followed by about 10 years of sharply-reduced catches; (2) a later period from 1916-1940 in which annual landings were relatively stable, fluctuating between 5,000 - 11,500 mt and averaging 8,300 mt per year; (3) a period from 1941-1963 when landings sharply increased (1945: 14,500 mt) and then rapidly decreased, reaching a record-low of 2,600 mt in 1957; and (4) the most recent period from 1964 onward during which Gulf of Maine landings have generally increased. Total landings doubled between 1964 and 1968, doubled again between 1968 and 1977, and averaged 12,200 mt per year during 1976-1985 (Table 1). Although Gulf of Maine landings declined between 1984 and 1987, landings subsequently increased, reaching 17,800 mt in 1991, the highest level since the early 1900s. Total landings declined sharply in 1992 to 10,891 mt, decreased further in 1993 to 8,287 mt, and have remained approximately within the 7,000-8,000 mt range during 1994-1996.

This report presents an updated and revised analytical assessment of the Gulf of Maine cod stock (NAFO Division 5Y) for the period 1982-1996 based on analyses of commercial and research vessel survey data through 1996. From the early 1960s through 1993, information on the catch quantity by market category was derived from reports of landings transactions submitted voluntarily by processors and dealers. More detailed data on fishing effort and location of fishing activity were obtained for a subset of trips from personal interviews of fishing captains conducted by port agents in the major ports of the Northeast. Information acquired during the course of these interviews was used to augment the total catch information obtained from the dealer. After 1993, however, procedures for collecting and processing commercial fishery data in the Northeast were substantially revised.

Beginning in 1994, information on fishing effort and catch location was no longer obtained from personal interviews of fishing captains. Instead, data on number of hauls, average haul time, and catch locale were obtained from logbooks submitted to National Marine Fisheries Service (NMFS) by operators fishing for groundfish in the Northeast under a mandatory reporting program. Estimates of total catch by species and market category were derived from mandatory dealer reports submitted on a trip basis to NMFS. Catches by market category were allocated to stock based on a matched subset of trips between the dealer and logbook databases. Data in both databases were stratified by calendar quarter, port group, and gear group to form a pool of observations from which proportions of catch by stock could be allocated to market category within the matched subset. The cross-products of the market category by stock proportions derived from the matched subset were employed to compute the total catch by stock, market category, calendar quarter, port group and gear group in the full dealer database. A full description of the proration methodology and an evaluation of the 1994-1996 logbook data is given in Wigley *et al.* (1997) and DeLong *et al.* (MS 1997), and a description of data entry and auditing procedures is provided by Power *et al.* (MS 1997).

An initial analytical assessment of this stock was presented at the Seventh NEFC Stock Assessment Workshop in November 1988 (NEFC 1989) and subsequent revisions were presented at the 12th, 15th, and 19th Northeast Regional Stock Assessment Workshops in June 1991, December 1992, and December 1994 (NEFSC 1991, 1993, 1995; Mayo *et al.* 1993; Mayo 1995).

THE FISHERY

Commercial Fishery Landings - Annual commercial landings data for Gulf of Maine cod in years prior to 1994 were obtained from trip-level detailed landings records contained in master data files maintained by the Northeast Fisheries Science Center, Woods Hole, Massachusetts (1963-1993) and from summary reports of the Bureau of Commercial Fisheries and its predecessor the U.S. Fish Commission (1895-1962). Beginning in 1994, landings estimates were derived from dealer reports prorated to stock based on the distribution of reported landed catch contained in fishing vessel logbooks as described above.

Total commercial landings in 1996 were 7,194 mt, 6% greater than in 1995, but 60% less than the 1991 peak (Table 1). Since 1977, the USA fishery has accounted for all of the commercial catch. Canadian landings reported as Gulf of Maine catch during 1977-1990 are believed by Canadian scientists to be misreported catches from the Scotian Shelf stock (Campana and Simon 1985; Campana and Hamel 1990). Although otter trawl catches account for most of the landings (56% by weight in 1996), the quantity taken by gill nets increased to over 40% in 1994 and 1995 from a low of 23% in 1991; the 1996 gill net percentage was similar to 1987-1989 (Table 2).

Commercial Fishery Discards - Discard rates were calculated by quarter and gear from NEFSC sea sampling data collected between 1989 and 1996 (Table 3). Discard and kept components of the catch were summed for all observed tows, within each gear type, occurring in Division 5Y, and the ratio of the discarded to kept quantity was applied to landings for the corresponding quarter and gear type within each year. Data were available for otter trawls, shrimp trawls and sink gill nets. Calculations and sample sizes are given in Appendix 1:Tables 1-3 and Figures 1-3.

Discard to kept ratios and absolute quantities were highest in 1989 and 1990 for the otter trawl and shrimp trawl gear. Ratios in the otter trawl fishery declined from 0.30-0.60 in 1989 and 1990 and remained low through 1996, fluctuating between 0.002 and 0.155. In the shrimp trawl fishery, ratios remained high throughout 1989-1991, but declined substantially in 1992 and remained negligible in 1993. Sea sampling data for 1994-1996 were minimal; therefore, landings by this gear component were not distinguished from all other otter trawls in the proration scheme employed to derive the landings by stock for the present assessment. Consequently, discard estimates from both otter trawl and shrimp trawl gear were combined for the 1994-1996 period.

Discards of Gulf of Maine cod ranged from 176 mt in 1996 to 3,599 mt in 1990 (Table 3). Discards exceeded 1,000 mt in each year between 1989 and 1991 before declining steadily since 1992. The relatively high discard rates calculated for otter trawl and shrimp trawl gear during 1989-1991 coincide with recruitment of the strong 1987 year class to the small mesh shrimp trawl gear and then the large mesh general otter trawl gear. Available length composition data for these gear types suggest that most of the discarded cod were about 30-50 cm with a mode around 40 cm. Discards emanating from these two gears are the likely result of minimum size regulations. In contrast, the relatively low, but persistent, discards of cod in the gill net fishery comprised fish of all sizes, up to 125 cm. The larger size range reflects discarding resulting from minimum size regulations as well as poor fish quality (in the case of the larger, marketable cod).

Recreational Fishery Catches - Estimates of the recreational cod catch were derived from the Marine Recreational Fishery Statistics Survey (MRFSS) conducted annually since 1979. The Gulf of Maine cod catch was estimated assuming that catches of cod recorded by that portion of the intercept survey were removed from the ocean in statistical areas adjacent to the state or county of landing. The MRFSS database has been recently revised, resulting in adjusted catch estimates for the years 1981 through 1996. Revised estimates of the total Gulf of Maine cod recreational catch as well as the portion of the catch excluding those caught and released are provided in Table 4. Information on the catch prior to 1981, which has not been revised, is included in Table 4 to provide a longer-term perspective. Further information on the details of the allocation scheme and sampling intensity are given in NEFSC (1992).

The quantity of cod retained generally exceeded 75% of the total recreational catch from 1979 through 1991, but has averaged less than 50% since 1992. The estimated total recreational cod catch declined from over 5,000 mt in 1980 and 1981 to less than 2,000 mt between 1983 and 1986, increased to over 3,500 mt in 1990 and 1991 and has fluctuated between 1,200 and 2,600 mt since 1992.

Commercial Fishery Sampling Intensity - A summary of USA length frequency and age sampling of Gulf of Maine cod landings during 1982-1996 is presented in Table 5. USA length frequency sampling averaged one sample per 155-200 mt landed during 1983-1987 but the sampling intensity was reduced in 1990 (1 sample per 387 mt) and 1993 (1 sample per 360 mt), and the absolute level of sampling was extremely low in 1993. Overall sampling improved slightly in 1994 and 1995, but the seasonal distribution was uneven and poorly matched to the landings. Sampling improved substantially in 1996, reaching an all-time high in terms of both absolute number of samples and samples per ton landed.

Virtually all of the USA samples have been taken from otter trawl landings, but sampling and the estimation of length composition is stratified by market category (scrod, market, and large). Although the length composition of cod differs among gear types (primarily between otter trawl and gillnet), the length composition of cod landings within each market category is virtually identical among gear types. Of the 77 samples collected in 1996, 27 were scrod samples (35%), 38 were market (49%), and 12 were large (16%). Compared with the 1996 market category landings distribution by weight (scrod: 23%; market: 61%; large: 13%) (Table 6), sampling in 1996 reasonably approximated the market category distribution of the landings.

Commercial Landings Age Composition - The age composition of landings during 1982-1993 was estimated, by market category, from monthly length frequency and age samples, pooled by calendar quarter. Quarterly mean weights, by market category, were obtained by applying the NEFSC research vessel survey length-weight equation for cod:

$$\ln \text{Weight}_{(\text{kg}, \text{live})} = -11.7231 + 3.0521 \ln \text{Length}_{(\text{cm})}$$

to the quarterly market category sample length frequencies. Computed mean weights were then divided into quarterly market category landed weight to derive estimated numbers landed by

quarter, by market category. Quarterly age/length keys were applied to the quarterly market category numbers at length distributions to provide numbers at age. These results were summed over market categories and quarters to derive the annual landings-at-age matrix (Table 7a).

Age composition of landings from 1994 through 1996 were estimated in a manner similar to that employed for the 1982-1993 estimates except that samples and landings were, on occasion, pooled to the semi-annual level because of the uneven distribution of length and age samples by quarter (Table 5). Semi-annual pooling was required for the 1st and 2nd quarters of 1994 because of incomplete sampling coverage of scrod and large cod landings; in 1995, samples were pooled in both semi-annual periods due the absence of large cod samples and the sparse coverage of market cod in quarters 1 and 3. Quarterly allocation of samples to landings was achieved for all market categories in 1996.

Gulf of Maine cod landings are generally dominated by age 3 and 4 fish in numbers and ages 3, 4 and 5 by weight. Cod from the strong 1987 year class predominated from 1990 through 1992 but, by 1993, fish from the 1990 year class accounted for the greatest proportion of the total number landed (Table 7a). In terms of weight, the 1993 landings were equally distributed between the 1987 and 1990 year classes. In 1993, these two year classes accounted for approximately 70% of the total number and weight landed. From 1994 through 1996, landings were dominated by age 4 cod in both number and weight. Although traditionally low in terms of their contribution to the total landings, age 10 and 11+ fish were completely absent in 1993 and 1996, and numbers of age 8 and 9 fish have also been unusually low (Table 7a). Although this pattern may be partly a result of the poor sampling of 'large' category cod, a trend towards fewer older fish in the landings has been apparent since 1991. As well, the contribution of age 2 fish to the landings has decreased in recent years.

Commercial Landings Mean Weights at Age - Mean weights at-age in the catch for ages 1-11+ during 1982-1996 are given in Table 7b and, based on landings patterns, are considered mid-year values. Mean weights of age 2 and 3 cod have risen since about 1992, reflecting decreased partial recruitment of younger fish to the fishery, while those for intermediate aged fish have fluctuated without any particular trend. Mean weights for ages 9 and older age fluctuate considerably and are particularly sensitive to sampling variability. Thus, it is unlikely that the apparent increases in mean weight at age for ages 10 and 11+ since the late 1980s would indicate a shift in growth or an increase in older fish in the plus group.

In 1990, mean weights at age for age groups 2 and 4 were the lowest in the nine-year time series while mean weights for age groups 6, 7 and 9 were the highest. These changes, however, may be artifacts of the reduced sampling intensity of the landings in 1990. Mean weights at ages 8 and 9 in 1993 and at ages 5 and 6 in 1995 were the highest in the series, but these anomalies are also the likely result of poor sampling. However, the increase in mean weights at age 2 in 1995 and 1996 may be related to the use of 152 mm (6 in.) mesh in the otter trawl fishery. Catch at age and recalculated mean weights at age for the 7+ group which are used in the VPA are given in Tables 8a and 8b. Mean weights at age for calculating stock biomass at the beginning of the year are provided in Table 9. These values were derived from the catch mean weight at age data (Table 7b) using the procedures described by Rivard (1980).

Recreational Fishery Sampling Intensity - Information on the length frequency sampling levels of Gulf of Maine cod taken in the recreational fishery is provided in Table 4. An examination of the available length frequency sampling coverage was conducted to evaluate the potential utility of these data in estimating the overall length composition of the recreational cod catch. Overall, sampling for cod taken by recreational gear is poor, averaging less than 1 sample per 1,000 mt removed (Table 4). The length composition data, however, provide a general indication of the size composition of the catch. Length frequency sample data, summarized by wave and fishing mode over the 16-year period from 1981-1996, display only minor variation among seasons and fishing modes. Most cod caught are in the 40-70 cm range, with few fish larger than 100 cm. Length frequency data are available only for fishing modes 6 and 7 and waves 2 through 6 (March-December). These data, in conjunction with estimates of mean weight of the catch, indicate that cod taken in the recreational fishery are generally smaller, on average, than those taken by the commercial sector. The mean weights of cod taken in the recreational fishery (1.5-2.0 kg; Table 4) are comparable to those of age 2-3 cod in the commercial landings, or approximately equal to the mean weight of the scrod market category.

Recreational Landings Age Composition - Given the limited sampling coverage in this sector of the fishery, estimation of numbers caught by length and age required that samples be pooled on an annual basis. The low inter-seasonal variability displayed by the sample length composition data supports this approach. Differences between fishing modes 6 and 7 are also minimal. Therefore, estimates of the age composition of recreationally caught cod were derived from the length composition data applied to the retained number of cod based on pooled annual length frequency samples from Gulf of Maine trips. Only the retained cod were included because the intercept sampling does not accurately reflect the size composition of the released cod. Age-length keys obtained from sampling the commercial landings, augmented by age samples from NEFSC bottom trawl surveys for cod less than 40 cm, were applied to the number retained at length on an annual basis to derive the number retained at age (Table 10a).

Between 1982 and 1988, the Gulf of Maine cod recreational catch in number was dominated by age 3 fish, with age 2 fish next in importance. Since 1989, however, ages 3 and 4 cod dominated the catches. The strong 1987 year class dominated the catch in 1990, 1991 and 1992, at ages 3, 4 and 5, respectively. Age 3 and 4 cod generally predominated in terms of weight caught, although the 1987 year class was dominant in 1992 at age 5. The 1982-1988 pattern represents a one age downward shift compared to the commercial landings at age, whereas the age composition since 1989 is more consistent with the commercial age composition. The earlier differences may reflect gear selectivity and the spatial distribution of the commercial and recreational fishing effort. The contribution of age 1 cod has become negligible in recent years.

Recreational Landings Mean Weights at Age - Mean lengths and weights at age of recreationally-caught cod (Table 10b) were consistently lower than those taken in the commercial fishery. This pattern persists through age 5 but, for ages 6 and older, mean weights are highly variable due to the relatively poor sampling of fish at the larger sizes, combined with the lack of market category stratification.

STOCK ABUNDANCE and BIOMASS INDICES

Commercial Catch Rates - USA commercial LPUE indices (landings per unit effort, expressed in metric tons landed per day fished) were calculated from otter trawl trips landing cod from the Gulf of Maine (Division 5Y) between 1982 and 1996. Due to the change in data collection procedures implemented in 1994, methods employed to compute LPUE for the 1994-1996 period differed from those used to compute indices from 1982-1993.

The 1982-1993 Series - Standardized effort and LPUE series for Gulf of Maine cod for the period prior to 1994 were developed for a sub-fleet by applying a five-factor (year, area, quarter, tonnage class and depth) General Linear Model (GLM) to log LPUE data derived for all interviewed otter trawl trips taking cod from 1982 through 1993. Details regarding data selection and preparation and model formulation are provided by Mayo *et al.* (1994).

Effort standardization factors employed in the previous Gulf of Maine cod assessment were based on a GLM using data from 1982 through 1992. Standardized effort for the 1982 period and for 1993 were derived from the cross products of year, area, quarter, tonnage class and depth cell coefficients corresponding to the 1982-1992 period. For the present assessment, cell coefficients were re-computed using the same GLM formulation based on data from 1982 through 1993 inclusive. During the course of this analysis, it was discovered that a coefficient for one level of one factor (tonnage class 32) was mis-specified in the effort standardization software. The class 32 coefficient of 2.35 (Mayo 1995; Table 13) was erroneously entered as 0.55. When the previous effort analysis was re-run with the correct entry, the resulting effort series increased by about 22% across all years, i.e., standardized effort was re-scaled up by 22%. The impact of this change on the VPA outcome was minimal since the temporal pattern of LPUE was similar: terminal F in 1993 increased from 0.93 to 0.94 (1%), terminal population estimates decreased by a corresponding amount, and coefficients of variation of the population estimates remained unchanged.

The 1994-1996 Series - Beginning in 1994, information on fishing effort was no longer obtained from personal interviews of fishing captains. Instead, effort data for the 1994-1996 period were obtained from NMFS Northeast Region Vessel Trip Report (VTR) databases which were subjected to preliminary audits on selected fields (Power *et al.* MS 1997). These logbook data were extracted from the same database used to prorate total landings by stock. Fishing effort from otter trawl trips landing Gulf of Maine cod was computed from logbook records in which cod were reported from locations within Division 5Y. Effort in terms of days fished was computed as the product of the reported average haul time and the total number of hauls, converted to 24 hour days. Filtering of suspected outliers was performed. Trip data were aggregated in the same manner as the 1982-1993 interview records, i.e., by year, area, quarter, tonnage class and depth categories. Nominal effort for 1994-1996 was then adjusted by the cell cross products derived from the 1982-1993 GLM results to produce the standardized effort and LPUE series for this period.

Trends in LPUE and Fishing Effort - The LPUE analysis presented in previous assessments using 'calculated effort' from cod trips weighted by catch within tonnage class was discontinued in the present assessment. However, previous information on the proportion of 'directed' cod trips, in which cod comprised 50% or more of the total trip catch by weight, and the catch-weighted LPUE series based on all cod trips was retained to provide an historic perspective.

Directed trips have generally accounted for less than 45% (and as low as 14%) of USA Gulf of Maine otter trawl landings of cod but after 1987 'directed trips' began to account for an increasing percentage of the total catch (Table 11). The fraction of the otter trawl catch taken on 'directed trips' increased from 15% of the total in 1987 to 71% in 1991. The 'directivity' of the otter trawl fishery declined in 1992 and 1993 to about 50%. The temporary increase in directivity, which peaked in 1991, is the likely result of the dominant influence of the unusually strong 1987 year class in the fishery. This suggests that the very high 1990 and 1991 total LPUE indices were rather inflated due to a marked change in fleet 'directivity'. This trend is apparent within and among all vessel class categories, but was particularly evident in class 4 (Mayo 1995).

Calculated LPUE values based on catch-weighted effort, within vessel tonnage class, increased during the late 1960s, declined during the early 1970s, sharply increased in 1974, and then stabilized during 1975-1983 at a relatively high level (Table 12). After 1983, LPUE indices tended downward, reaching record-low levels in 1987. The LPUE index increased between 1988 and 1991, attaining its highest value since 1977 (among the highest in the time-series). In 1992 and 1993, LPUE declined sharply, approaching the lowest on record in 1993. In terms of calculated effort (total landings/LPUE index), total fishing effort reached a record-high level in 1987, declined from 1988 to 1990, and has since increased well above the 1990 level (Table 12). To the extent that the 1990 and 1991 total LPUE indices were inflated (due to increased fleet 'directivity' for cod), the calculated effort values for 1990 and 1991 are underestimated. Therefore, the total calculated effort on Gulf of Maine cod since 1984 appears to have remained at a consistently high level relative to the 1960s and 1970s.

The updated 1982-1993 general linear model accounted for just under 25% of the total sum of squares variation in LPUE, and all five factors were highly significant (Table 13). For each year between 1982 and 1993, standardized effort in each area-quarter-tonnage class-depth category was estimated by multiplying the sum of the nominal effort for that cell by the product of the re-transformed GLM coefficients for each factor. The estimated standardized sub-fleet effort was then accumulated over all categories to provide annual estimates as given in Table 14. Total standardized effort was calculated by raising the sub-fleet effort to account for all cod landings.

The 1982-1993 age composition of the landings corresponding to the effort sub-fleet as presented by Mayo *et al.* (1994) was used with the updated standardized effort estimates to calculate a revised LPUE at age index. Numbers landed at age were estimated by applying quarterly commercial age-length keys to quarterly commercial numbers landed at length by market category. The LPUE at age indices were derived by dividing the estimated numbers landed at age by corresponding 1982 through 1993 standardized fishing effort. Further details regarding data selection, preparation and estimation procedures are provided in Mayo *et al.* (1994).

Standardized fishing effort increased during the 1980s with peak effort occurring in 1987. Effort declined thereafter and remained variable between 1991 and 1993 (Table 14, Figure 2). As well, standardized LPUE declined gradually between 1982 and 1987, increased steadily until 1990 and then declined sharply by about 50-60% between 1991 and 1993 (Table 14, Figure 3). Over the 1982-1993 period, when both series were available, standardized LPUE and the weighted average LPUE based on all cod trips were rather consistent in both scale and trend (Figure 3).

Estimated standardized effort increased sharply in 1994, but declined thereafter, returning to pre-1994 levels by 1996. The abrupt increase in the 1994 raised effort (Figure 2) reflected a corresponding increase in the observed nominal and estimated standardized effort in the otter trawl sub-fleet (Table 14). The reported landings for the corresponding VTR trips declined sharply in 1994, however, resulting in a substantial decrease in the ratio of landings to nominal effort and the consequent standardized LPUE index. The sharp increase in raised effort occurred when the low sub-fleet LPUE index was raised to total landings. Standardized LPUE gradually increased over the 1994-1996 period, but remained well below the 1993 LPUE index (Figure 3).

The reasons for this dramatic one-year increase in estimated effort in 1994, followed by a more gradual decline in 1995 and 1996 may be related to changes in reporting methods, use of unaudited effort fields in the VTR data sets, or a change in the relationship between otter trawl LPUE and fixed gear LPUE. In the VTR data, effort is recorded in two fields, number of hauls and average haul duration. Trip effort must then be computed as the product of these factors. If either field is misinterpreted or entered incorrectly, the resulting effort estimate for the trip may be in error. A preliminary scan of the effort fields revealed some very large outliers. Consequently, data included in the effort calculations were restricted to computed effort of 12 days fished or less per trip. Analyses of the 1994-1996 computed effort per trip by DeLong *et al.* (MS 1997) indicated an abrupt shift in the distribution of 1994-1996 LPUE values towards a greater frequency of low LPUE and low effort trips compared to the 1991-1993 period.

As well, it is not known whether the landings reported in the VTR data reflect whole or eviscerated weights. Estimates of standardized effort and LPUE for 1994-1996 provided in Figures 2 and 3 were derived to account for either assumption: i.e., the higher LPUE and lower estimates of effort correspond to the assumption that the kept portion of the catch reported on VTR records reflected fish in eviscerated condition. Given the uncertainty about the effort data in the VTR data sets, estimates of effort and LPUE for 1994-1996 must be considered provisional, and further analyses of the VTR-based estimates of LPUE in relation to the interview-based estimates are required.

Research Vessel Survey Indices - Indices of cod abundance (stratified mean catch per tow in numbers) and biomass (stratified mean weight per tow in kilograms), developed from Northeast Fisheries Science Center (NEFSC) and Commonwealth of Massachusetts Division od Marine Fisheries (DMF) research vessel bottom trawl survey data, have been used to monitor changes and assess trends in population size and recruitment of cod populations off New England. Offshore (> 27 m) stratified random NEFSC surveys have been conducted annually in the Gulf of Maine in autumn since 1963 and in spring since 1968. Inshore areas of the Gulf of Maine (<

27 m) have been sampled during spring and autumn NEFSC and DMF inshore bottom trawl surveys since 1978. For the NEFSC surveys, a "36 Yankee" trawl has been the standard sampling gear except for the spring 1973-1981 period when a modified "41 Yankee" trawl was used.

Prior to 1985, BMV oval doors (550 kg) were used in all NEFSC surveys; since 1985, Portuguese polyvalent doors (450 kg) have been used. Details on NEFSC survey sampling design and procedures are provided in Azarowitz (1981) and Clark (1981). The DMF inshore bottom trawl sampling program is described in Howe *et al.* (1981). No adjustments in the survey catch per tow data for cod have been made for any of the trawl differences, but vessel and door coefficients have been applied to adjust the stratified means (number and weight per tow) as described in Table 15. Unadjusted catch per tow (number) at age indices from NEFSC spring and autumn surveys are listed in Appendix 2:Table 1 and standardized catch per tow (number) at age indices are listed in Appendix 2:Table 2. Catch per tow (number) at age indices from Massachusetts spring and autumn surveys are listed in Appendix 2:Table 3.

NEFSC spring and autumn offshore catch per tow indices for Gulf of Maine cod have generally exhibited similar trends throughout the survey time series (Table 15, Figure 4). Number per tow indices declined during the mid- and late 1960s but since 1972-73 have fluctuated as a result of a series of recruitment pulses. Sharp increases in the number per tow indices reflect above average recruitment of the 1971, 1973, 1977-1980, 1983, and 1985-1987 year classes at ages 1 and 2 (Appendix 2:Table 2, Figure 5). The sequential dominance of these cohorts at older ages can be discerned from number per tow at age values in both spring and autumn NEFSC surveys (Appendix 2:Table 2).

Spring NEFSC number per tow indices have remained relatively low since 1985 at a level below the 1981-1984 average (Table 15); spring weight per tow indices have also remained relatively low through 1991 but the index increased substantially in 1992, and remained relatively high in 1993, due to a large contribution from the 1987 year class (Appendix 2:Table 2). The index declined markedly in 1994, remained low in 1995 and increased moderately in 1996. Autumn number and weight per tow indices declined sharply in 1991 to unprecedented low levels; weight per tow continued to decline to record low levels through 1993 and has remained extremely low through 1996 (Figure 4). Increased abundance in 1988 and 1989, resulting from recruitment of the strong 1986 and 1987 year classes, were depleted by 1991, resulting in the sharp declines in the overall index. This reduction, combined with a general paucity of large fish in the surveys in recent years (Appendix 2:Table 2) has resulted in the decline and persistence of low weight per tow indices since 1991. Overall, the 1987 year class appears to have been one of the strongest ever produced; catch per tow indices of this cohort at ages 1-3 in the NEFSC autumn surveys and at ages 0 and 1 in the Massachusetts DMF autumn inshore surveys were nearly all record-high values (Appendix 2:Tables 2 and 3). Based on Massachusetts DMF and NEFSC survey catch per tow indices from 1989-1996, only the 1992 year class appears to be of moderate strength; the remaining year classes of Gulf of Maine cod appear to be below average, and the 1994 and 1995 year classes are likely to be record lows.

MORTALITY

Total Mortality Estimates - Pooled estimates of instantaneous total mortality (Z) were calculated for nine time periods encompassed by the NEFSC spring and autumn offshore surveys: 1964-1967, 1968-1972, 1973-1976, 1977-1981, 1982-1984, 1985-1987, 1988-1990, 1991-1993, and 1994-1996 (Table 16). Total mortality was calculated from survey catch per tow at age data (Appendix 2:Table 2) for fully recruited age groups (age 3+) by the log_e ratio of the pooled age 3+/age 4+ indices in the autumn surveys, and the pooled age 4+/age 5+ indices in the spring surveys. For example, the 1982-1984 values were derived from:

$$\text{Spring: } \ln(\sum \text{age 4+ for 1982-84} / \sum \text{age 5+ for 1983-85})$$

$$\text{Autumn: } \ln(\sum \text{age 3+ for 1981-83} / \sum \text{age 4+ for 1982-84})$$

Different age groups were used in the spring and autumn analyses so that Z could be evaluated over the same year classes within each time period.

Except for the 1988-1990 and 1994-1996 periods, values of Z derived from the spring surveys are slightly lower than those calculated from the autumn data. Rather than selecting one survey series over the other, total mortality was calculated by taking a geometric mean of the spring and autumn estimates in each time period. The pooled estimates indicate that total mortality was relatively low ($Z = 0.40$) between 1964 and 1976 but increased significantly thereafter to 0.75-0.78 during 1982-1987. Total mortality increased further to 0.94 during 1988-1990, to 1.10 during 1991-1993, and remained high (1.11) during 1994-1996.

Natural Mortality - Instantaneous natural mortality (M) for Gulf of Maine cod is assumed to be 0.20, the conventional value of M used for all Northwest Atlantic cod stocks (Paloheimo and Koehler 1968; Pinhorn 1975; Minet 1978).

ESTIMATION of FISHING MORTALITY RATES and STOCK SIZE

Virtual Population Analysis Calibration - The ADAPT calibration method (Parrack 1986, Gavaris 1988, Conser and Powers 1990) was used to derive estimates of terminal fishing mortality (F) in 1996. As in previous assessments, age-disaggregated analyses were performed. Several exploratory ADAPT formulations were performed using NEFSC spring and autumn (ages 2-6), and Massachusetts DMF spring (ages 2-4) and autumn (ages 2 and 3) survey series. Due to uncertainty in the interpretation of effort units in the 1994-1996 VTR data, USA commercial LPUE abundance indices for age 3-6 were included only through 1993. This change effectively removed the influence of the LPUE indices on the terminal year outcome of the calibration, while preserving the historic relationship employed in the previous assessment. As in the previous assessment (Mayo 1995), the USA commercial LPUE indices from 1982 through 1993 were

derived from the catch at age corresponding to the effort sub-fleet used in the estimation of standardized fishing effort as described by Mayo *et al.* (1994). The NEFSC and Massachusetts DMF autumn indices were lagged forward by one age and one year whereby age 1-6 indices were related to age 2-7 stock sizes in the subsequent year for corresponding cohorts. All NEFSC and Massachusetts DMF indices were related to January 1 stock sizes, and USA commercial LPUE indices were related to mid-year stock sizes.

The 1982-1996 commercial landings at age as provided in Table 7a includes true ages 2-10 as well as the 11+ group. In recent years, however, older fish beyond age 7 have been poorly represented. As reported by Mayo (1995), a previous calibration run employing an extended age complement (true ages 2-9) produced high coefficients of variation (CV) on the terminal year stock size estimates and variable estimates of F on ages 7-9 in most years prior to the terminal year. Therefore, as in previous assessments of this stock (Mayo *et al.* 1993; Mayo 1995) all trial formulations employed a reduced age range (ages 2-6 and 7+).

As in the past, Massachusetts DMF survey data were included in the VPA calibration primarily to improve the estimates of recruiting year class strength. In exploratory analyses, the DMF autumn age 3 (age 2 before lagging) index often accounted for up to 40% of the total sum of squares; this index was again, as in previous assessments, excluded from the final calibration because of its high variability. The series of trial formulations is summarized in Table 17. All of the trial calibrations employed equal weighting among indices in all years. The formulation identical to that employed in the previous assessment (Mayo 1995) is presented first. This formulation and the second one listed in Table 17 employed commercial landings at age data only as in all previous assessments. The second trial calibration included an extended age range in the landings data, but included direct estimates of ages 2-6 stock sizes as in the previous trial. Two additional trial calibration runs were performed, incorporating estimates of recreational landings at age. The first of these employed the same age range in the direct estimation of terminal populations and the same calibration block as the previous trials, while the second of the two trials incorporating recreational data included a direct estimate of age 1 numbers and two age 1 calibration indices from the Massachusetts DMF spring and autumn surveys.

In all trials, a rather sharp increase in the 1996 F is evident between ages 4 and 5, although the CVs are similar among trials. The F pattern in 1994 was also rather unstable in all formulations with unusually high Fs on ages 4 and 5, particularly on age 5. None of the variations on the initial formulation produced noticeably different results in terms of terminal Fs, population numbers, or CVs. The impact of including the recreational landings in the VPA was an increase in the 1997 terminal population numbers while changes in 1996 terminal F estimates were minimal. Incorporation of age 1 in the formulation slightly improved the precision of the estimate of the age 2 population numbers ($CV = 0.37$ vs. 0.46), but slightly reduced the precision of the estimate of the age 6 numbers ($CV = 0.65$ vs. 0.57). As well, age 1 numbers were poorly estimated ($CV = 0.74$). Prior to the terminal year, estimates of F at younger ages were generally higher and stock size estimates at all ages increased over those obtained from the trial which employed only commercial landings at age. Noting (a) the low precision on ages 1 and 6, (b) taking into account the poor length sampling for cod in the recreational fishery, and (c)

recognizing the rather uncertain estimates of the recreational catch allocation between the Gulf of Maine and Georges Bank stocks, recreational landings were excluded from the final VPA. The ADAPT formulation employed in the final VPA calibration provided direct stock size estimates for ages 2 through 6 in 1997 and corresponding estimates of F on ages 1 through 5 in 1996. Since the age at full recruitment was defined as 4 years in the input partial recruitment vector, the terminal year F on age 6 was estimated as the mean of the age 4 and 5 Fs; age 6 is also the oldest true age in the terminal year. In all years prior to the terminal year, F on the oldest true age (age 6) was determined from weighted estimates of Z for ages 4 through 6. In all years, the age 6 F was applied to the 7+ group. Spawning stock biomass (SSB) was calculated at spawning time (March 1) by applying a series of period-specific maturity ogives provided by O'Brien (pers. comm.).

Virtual Population Analysis Results - Full results from the final VPA calibration are presented in Appendix 3, and estimates of F, stock size, and spawning stock biomass are given in Table 18. Except for a few cases, the final calibration yielded low correlations (< 0.10) among estimates of slopes (q) and moderately low correlations (< 0.20) between stock sizes and qs. The highest correlations were noted between stock size estimates and the NEFSC spring and autumn abundance index for the corresponding age (Appendix 3, page 11). All parameter estimates were significant. Coefficients of variation on the stock size estimates ranged from 0.31 (ages 3 and 4) to 0.57 (age 6), while CVs on the estimates of slopes were between 0.16 and 0.18. Slopes of the abundance index-stock size relationships (Appendix 3, page 10) increased with age generally up to age 4 for the NEFSC spring and autumn surveys and the USA commercial LPUE indices. The Massachusetts DMF indices also exhibited an increasing trend in q between ages 2 and 4.

Average (ages 4-5, unweighted) fishing mortality in 1996 was estimated at 1.04 (Table 18, Figure 6). This high level of mean fully-recruited F is consistent with estimates of continued high fishing effort indicated by the general linear modelling results (Figure 3). The spawning stock biomass of mature cod age 2 and older declined from 22,445 mt in 1982 to 14,343 mt in 1987. Following the recruitment and maturation of the strong 1987 year class, SSB increased sharply in 1989 to a maximum of 26,080 mt but declined to 8,593 mt in 1994, a 5-year reduction of 67% (Table 18, Figure 7). SSB increased by 13% to 9,719 mt in 1995 due to the growth and maturation of the 1992 year class, but the spawning biomass declined again in 1996. Total stock size (ages 2+) has also declined sharply in recent years from 28 million fish in 1989 to 4.2 million in 1997, a decrease of 85% (Table 18).

Since 1982, recruitment at age 2 has ranged from less than 1 million fish (1994 and 1995 year classes) to 17.7 million fish (1987 year class). Over the 1982-1996 period, geometric mean recruitment for the 1980-1994 year classes was 4.7 million fish. The 1987 year class is the highest in the 1982-1996 series and about twice the size of the above average 1980 and 1986 year classes. Except for the moderate 1992 year class, recent recruitment has been poor as the 1988-1989 and the 1993-1995 year classes (all ≤ 3.1 million at age 2) are estimated to be among the poorest in the series (Table 18, Figure 7). In particular, the 1994 and the 1995 year classes are each estimated to be less than 1 million fish.

Precision of F and SSB - A bootstrap procedure (Efron 1982) was used to evaluate the precision of the final estimates, by generating 1,000 estimates of the 1996 fishing mortality rate and spawning stock biomass. The distributions of the bootstrap estimates and the corresponding cumulative probability curves are shown in Figures 8 and 9. The cumulative probability expresses the likelihood that the fishing mortality rate was greater than a given level (Figure 8) or the likelihood that spawning stock biomass was less than a given level (Figure 9), when measurement error is considered. An evaluation of the precision of the 1997 stock size, 1996 fishing mortality, 1996 spawning stock biomass, and q estimates is presented in Appendix 4.

Coefficients of variation for the 1997 stock size (numbers) estimates ranged from 0.31 (age 3) to 0.70 (age 6), and CVs for qs among all indices ranged from 0.15 to 0.19 (Appendix 4:Table 1). Fully-recruited fishing mortality in 1996 for ages 4+ was reasonably well estimated (CV = 0.25). The mean bootstrap estimate of F (1.079) was slightly higher than the point estimate (1.036) from the VPA (Appendix 4:Table 5) and individual bootstrap estimates ranged from 0.46 to 2.04. The 80% probability interval ranges from 0.79 to 1.41 (Figure 8). $F_{20\%}$ and F_{max} are much lower than the lowest bootstrap estimate, and F_{1996} is certainly above the overfishing definition mortality rate and the maximum F allowable to achieve stock rebuilding.

Although the abundance estimates for individual ages in 1997 had wide variances (CV = 0.31 to 0.70), the estimate of 1996 spawning stock biomass was robust (CV = 0.15). The bootstrap mean (9,585 mt) was slightly higher than the VPA point estimate (9,249) (Appendix 4:Table 6) and individual bootstrap estimates ranged from 6,000 mt to 14,700 mt. The 80% probability interval ranges from 7,800 mt to 11,300 mt (Figure 9). Despite this variability, spawning stock biomass in 1996 is estimated to be among the lowest observed in the VPA time series.

In general, estimates of stock size and fishing mortality in the present assessment are slightly less precise than in the previous assessment of this stock (Mayo 1995). This may be due to greater variability in the estimates of landings at age resulting from lower sampling in recent years, or to the exclusion of commercial LPUE indices in the most recent years of the VPA calibration. Despite this lower precision, the VPA results are sufficient to accurately characterize the overall status of the Gulf of Maine cod stock.

Retrospective Analysis - Retrospective analyses of the Gulf of Maine cod VPA were carried out using the final ADAPT formulation with the terminal year ranging from 1996 back to 1991. Results are given in Table 19 and Figure 10. Convergence of estimates is generally evident within 3 years, and often within 2 years, prior to any given terminal year. Retrospective patterns with respect to terminal F are evident for Gulf of Maine cod in the most recent years. Mean (ages 4-5, unweighted) F in the terminal year was generally under-estimated by the ADAPT calibration in the most recent years and slightly over-estimated in earlier years. Terminal Fs appear to have been well estimated through 1993. Despite these patterns, the retrospective analysis provides additional evidence to substantiate the current high levels of F. Retrospective patterns for SSB and age 2 recruits are similar, both indicating relatively consistent estimates of terminal year values from 1991-1996. Although subject to some variability, terminal year recruitment and SSB appear to have been estimated with a high degree of reliability in recent years.

YIELD and SPAWNING STOCK BIOMASS per RECRUIT

Yield, total stock biomass, and spawning stock biomass per recruit analyses were performed using the method of Thompson and Bell (1934). Mean weights at age for application to yield per recruit were computed as a 15-year arithmetic average of catch mean weights at age (Table 7b) over the 1982-1996 period. Mean weights at age for application to SSB per recruit were computed as a 15-year arithmetic average of stock mean weights at age (Table 9) over the 1992-1996 period. The maturation ogive was the same as used in computing SSB during the 1990-1996 period in the VPA. To obtain the exploitation pattern for these analyses, a three-year geometric mean F at age was first computed over the period 1994-1996 from the final converged VPA results. These years were chosen specifically to encompass the period since enactment of the increase in the minimum allowable mesh (152 mm). A smoothed exploitation pattern was then obtained by dividing the F at age by the mean unweighted F for ages 4-5, and adjusting the age 2-4 ratios by the average for ages 5 and 6. The final exploitation pattern is as follows:

Age 1 0.000, Age 2 0.028, Age 3 0.211, Age 4 0.768, Ages 5+ 1.000

This pattern differs from those used in the previous two Gulf of Maine cod assessments (Mayo *et al.* 1993; Mayo 1995), and reflects recent management actions designed to increase mesh selectivity. This partial recruitment pattern was used in yield and SSB per recruit calculations (Table 20). Results of the yield and SSB per recruit calculations are listed in Table 20 and are illustrated in Figure 11. The yield per recruit analyses indicate that $F_{0.1} = 0.16$ and $F_{\max} = 0.29$, and SSB per recruit calculations indicate that $F_{20\%} = 0.37$. There reference points are either identical to, or slightly higher than, those reported in the previous assessment (Mayo 1995).

SHORT and MEDIUM-TERM PROJECTIONS

Short and medium-term projections of spawning stock biomass, recruitment at age 2 and commercial landings were performed using the VPA-calibrated 1996 fully recruited mean F (ages 4-5, u) and 1997 stock size estimates from the 1000 bootstrap replications as starting conditions. The stochastic simulations were repeated 50 times to obtain a series of probability profiles for each projected variable. The exploitation pattern and maturation rates were as described above for the yield and SSB per recruit analyses; catch and stock mean weights at age were computed as a five-year arithmetic average over the 1992-1996 period.

Short-Term Projections - Recruitment was generated based on the model 9 formulation of Brodziak and Rago (MS 1994). In this model, age 2 recruitment is estimated two years ahead by re-sampling the distribution of a specified range of empirical recruitment. For the near term, age 2 recruitment in 1997 was fixed at the level estimated in the VPA calibration, and recruitment in 1998 and 1999 was derived by re-sampling the distribution of values observed for the 1988-1994 year classes. Short-term projections are provided over a range of F levels which includes $F_{0.1}$, F_{\max} , $F_{20\%}$, and F_{sq} ($=F_{96}$). Input and output from the projections are given in Table 21. The assumption of status quo F in 1997 equal to 1.04 resulted in a 1997 catch of about 5,800 mt and a corresponding SSB of 6,900 mt. Given the delayed implementation of effort restrictions under Amendment 7 in 1997, and the potential for further shifts in fishing effort toward coastal Gulf of Maine grounds, the assumption of status quo F in 1997 appears reasonable.

Continued fishing at $F = 1.04$ in 1998 will result in projected 1998 landings of about 3,900 mt and will result in a continued decline in SSB to 4,300 mt in 1999 from the record low 1997 level of 6,900 mt (Table 21, Figure 12). SSB is projected to decline even further in 1999 if F remains at the current level in 1998. Even if fishing mortality is reduced to $F_{20\%}$ (0.37) in 1998 and 1999, SSB will not increase above the record-low 1997 level (Table 21, Figure 12).

Medium -Term Projection Results - Medium-term projections spanning a 10-year time horizon, beginning on January 1, 1997, are described and summarized by Overholtz *et al.* (1997) for five groundfish stocks in the Georges Bank region, including Gulf of Maine cod. A time series of spawning stock and recruitment data was assembled, and a probabilistic Beverton-Holt stock-recruitment relationship was established to estimate recruitment and associated variability in each of the forecast years. Starting conditions, including stock sizes in 1997, exploitation pattern, maturation schedules, and mean weights were as employed in the final VPA formulation as above. Medium-term projections for Gulf of Maine cod were performed over a range of F levels which included F_{\max} (0.29) and F_{sq} (1.04). Further details on application of stochastic projection methodology may be found in Brodziak and Rago (MS 1994) and Overholtz *et al.* (1997).

At the current level of fishing mortality ($F_{sq} = 1.04$), median SSB declines from about 6,800 mt in 1997 to 2,000 mt in 2006, and recruitment remains extremely poor, declining to less than 1 million fish per year after 2000; landings decline from 5,800 mt to 1,400 mt. Fishing at F_{\max} (0.29) over the 10-year time horizon results in considerably improved stock conditions. At this level of F , median SSB increases from 7,600 mt in 1997 to over 40,000 mt after 10 years, and recruitment improves from recent levels of about 1-2 million fish to about 7-8 million fish; landings increase from 2,200 mt in 1997 to about 11,000 mt in 2006 (Overholtz *et al.* 1997).

CONCLUSIONS

The Gulf of Maine cod stock is presently at a low biomass level and remains over exploited. Fishing mortality has remained at or near 1.0 since 1983, while spawning stock biomass (SSB) has declined from over 26,000 mt in 1989 to a record low of 8,600 mt in 1994, and is expected to decline further in 1997 to a new record-low of 6,900 mt. Accounting for the estimation uncertainty associated with the 1996 SSB (9,200 mt) and 1996 F (1.04) estimates, there is an 80% probability that the 1996 SSB lies between 7,800 mt and 11,300 mt, and that the 1996 F lies between 0.79 and 1.41. This further implies a 90% probability that the 1996 F was greater than 0.79, or more than two times greater than the overfishing definition ($F_{20\%}=0.37$).

At the present level of exploitation and probable levels of recruitment in the near term, further declines in spawning stock biomass are expected. At the current level of exploitation (60%), commercial landings are expected to decline to less than 4,000 mt in 1998 and spawning stock biomass is projected to decline to about 4,300 mt in 1999. Current SSB is no longer dominated by the 1987 year class, but by a series of very low to average year classes produced from 1988 through 1995. The moderate 1992 year class was the only above average year class since 1987. Recruitment from the two most recent year classes, produced in 1994 and 1995, is expected to be extremely poor, well below any previously observed levels.

An immediate and substantial reduction in fishing mortality, in the order of 65%, is required to halt the continuing decline in SSB. Rebuilding of SSB will require even further reductions over the long term. If fishing mortality is not reduced from the present level, SSB will decline to less than 5,000 mt in the near future.

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Table 1. Commercial landings (metric tons, live) of Atlantic cod the Gulf of Maine (NAFO Division SY), 1960 - 1996.¹

Year	Gulf of Maine				Total
	USA	Canada	USSR	Other	
1960	3448	129	-	-	3577
1961	3216	18	-	-	3234
1962	2989	83	-	-	3072
1963	2595	3	133	-	2731
1964	3226	25	-	-	3251
1965	3780	148	-	-	3928
1966	4008	384	-	-	4392
1967	5676	297	-	-	5973
1968	6360	61	-	-	6421
1969	8157	59	-	268	8484
1970	7812	26	-	423	8261
1971	7380	119	-	163	7662
1972	6776	53	11	77	6917
1973	6069	68	-	9	6146
1974	7639	120	-	5	7764
1975	8903	86	-	26	9015
1976	10172	16	-	-	10188
1977	12426	-	-	-	12426
1978	12426	-	-	-	12426
1979	11680	-	-	-	11680
1980	13528	-	-	-	13528
1981	12534	-	-	-	12534
1982	13582	-	-	-	13582
1983	13981	-	-	-	13981
1984	10806	-	-	-	10806
1985	10693	-	-	-	10693
1986	9664	-	-	-	9664
1987	7527	-	-	-	7527
1988	7958	-	-	-	7958
1989	10397	-	-	-	10397
1990	15154	-	-	-	15154
1991	17781	-	-	-	17781
1992	10891	-	-	-	10891
1993	8287	-	-	-	8287
1994*	7877	-	-	-	7877
1995*	6798	-	-	-	6798
1996*	7194	-	-	-	7194

* Provisional

¹ USA 1960-1993 landings from NMFS, NEFSC Detailed Weightout Files and Canvass data.

² USA 1994-1996 landings estimated by prorating NMFS, NEFSC Detailed Weightout data by Vessel Trip Reports.

Table 2. Distribution of USA commercial landings (metric tons, live) of Atlantic cod from the Gulf of Maine (Area 5Y), by gear type, 1965 - 1996.
 The percentage of total USA commercial landings of Atlantic cod from the Gulf of Maine, by gear type, is also presented for each year.
 Data only reflect Gulf of Maine cod landings that could be identified by gear type.

Year	Landings (metric tons, live)						Percentage of Annual Landings					
	Otter Trawl	Sink Gill Net	Line Trawl	Handline	Other Gear	Total	Otter Trawl	Sink Gill Net	Line Trawl	Handline	Other Gear	Total
1965	2480	501	462	168	1	3612	68.7	13.9	12.8	4.6	-	100.0
1966	2549	830	308	150	4	3841	66.4	21.6	8.0	3.9	0.1	100.0
1967	4312	734	206	274	<1	5526	78.0	13.3	3.7	5.0	-	100.0
1968	4143	1377	213	339	4	6076	68.2	22.7	3.5	5.6	-	100.0
1969	6553	851	258	162	4	7828	83.7	10.9	3.3	2.1	-	100.0
1970	5967	951	407	178	9	7512	79.4	12.7	5.4	2.4	0.1	100.0
1971	5117	1043	927	98	8	7193	71.1	14.5	12.9	1.4	0.1	100.0
1972	4004	1492	1234	54	2	6786	59.0	22.0	18.2	0.8	-	100.0
1973	3542	1182	1305	23	9	6061	58.4	19.5	21.5	0.4	0.2	100.0
1974	5056	1412	904	36	17	7425	68.1	19.0	12.2	0.5	0.2	100.0
1975	6255	1480	920	12	8	8675	72.1	17.1	10.6	0.1	0.1	100.0
1976	6701	2511	621	4	41	9878	67.8	25.4	6.3	0.1	0.4	100.0
1977	8415	2872	534	6	166 [a]	11993	70.2	23.9	4.5	-	1.4	100.0
1978	7958	3438	393	10	91 [b]	11890	66.9	28.9	3.3	0.1	0.8	100.0
1979	7567	2900	334	19	167 [c]	10987	68.9	26.4	3.0	0.2	1.5	100.0
1980	8420	3733	251	48	61	12513	67.3	29.8	2.0	0.4	0.5	100.0
1981	7937	4102	276	23	45	12383	64.1	33.1	2.2	0.2	0.4	100.0
1982	9758	3453	188	46	34	13479	72.4	25.6	1.4	0.3	0.3	100.0
1983	9975	3744	77	4	67	13867	71.9	27.0	0.6	-	0.5	100.0
1984	6646	3985	22	3	69	10725	62.0	37.2	0.2	-	0.6	100.0
1985	7119	3090	55	6	326 [d]	10596	67.2	29.1	0.5	0.1	3.1	100.0
1986	6664	2692	56	12	180 [e]	9604	69.4	28.0	0.6	0.1	1.9	100.0
1987	4356	2994	70	13	68	7501	58.1	39.9	0.9	0.2	0.9	100.0
1988	4513	3308	68	27	22	7938	56.9	41.7	0.8	0.3	0.3	100.0
1989	6152	4000	72	36	119 [f]	10379	59.3	38.5	0.7	0.4	1.1	100.0
1990	10420	4343	126	20	186 [g]	15095	69.0	28.8	0.8	0.1	1.2	100.0
1991	13049	4158	212	59	266 [h]	17744	73.5	23.4	1.2	0.3	1.5	100.0
1992	7344	3081	359	94	14	10891	67.4	28.3	3.3	0.9	0.1	100.0
1993	4876	3130	236	16	29	8287	58.8	37.8	2.8	0.2	0.3	100.0
1994	4205	3317	338	[i]	17	7877	53.4	42.1	4.3	[i]	0.2	100.0
1995	3450	3050	281	[i]	17	6798	50.8	44.9	4.1	[i]	0.3	100.0
1996	4012	2825	335	[i]	22	7194	55.8	39.3	4.7	[i]	0.3	100.0

[a] Of 166 mt landed, 107 mt were by mid-water pair trawl and 42 mt were by drifting gill nets.

[b] Of 91 mt landed, 56 mt were by Danish seine and 27 mt were by drifting gill nets.

[c] Of 167 mt landed, 199 mt were by drifting gill nets and 38 mt were by Danish seine.

[d] Of 326 mt landed, 268 mt were by longline and 37 mt were by Danish seine.

[e] Of 181 mt landed, 152 mt were by longline and 23 mt were by Danish seine.

[f] Of 199 mt landed, 75 mt were by longline and 27 mt were by Danish seine.

[g] Of 186 mt landed, 159 mt were by longline and 16 mt were by Danish seine.

[h] Of 266 mt landed, 245 mt were by longline and 9 mt were by Danish seine.

[i] Handline and line trawl combined.

Table 3. Discard and total catch estimates (metric tons, live) for Gulf of Maine cod by otter trawl, shrimp trawl, and sink gillnet gear.

Discard Estimates					
Year	Total Landings	Included Landings	Discard Estimate	Discard to Landings Ratio	Total Discard
1989	10397	10182	1513	0.1486	1545
1990	15154	14827	3521	0.2375	3599
1991	17781	17374	1032	0.0594	1056
1992	10891	10511	582	0.0554	603
1993	8287	8058	320	0.0397	329
1994	7877	7522	228	0.0303	239
1995	6798	6500	393	0.0605	411
1996	7194	6837	167	0.0244	176

Table 4. Estimated number (000's) and weight (metric tons, live) of Atlantic cod caught by marine recreational fishermen from the Gulf of Maine stock, 1979 - 1996.¹

Year	Total Cod Caught		Total Cod Retained (excluding those caught and released)				
	No. of Cod (000's)	Wt. of Cod (mt)	No. of Cod (000's)	Wt. of Cod (mt)	Sample Mean Weight (kg)	Number Measured	Percent of Total Landing
1979	2698	3466	not estimated		----- not estimated -----		
1980	2254	6860	not estimated		----- not estimated -----		
1981	2933	5944	2738	5549	1.595	380	30.7
1982	1833	2138	1736	2025	1.121	377	13.0
1983	1455	1388	1237	1180	1.323	882	7.8
1984	1098	1705	905	1405	1.520	596	11.5
1985	1671	1964	1471	1729	1.238	295	13.9
1986	1114	967	993	862	1.942	75	8.2
1987	2625	2317	2054	1813	1.738	320	19.4
1988	1487	2114	1300	1848	2.049	407	18.8
1989	1769	2690	1193	1814	1.736	404	14.9
1990	1725	3882	1247	2806	1.964	206	15.6
1991	1770	3635	1419	2914	2.004	370	14.1
1992	585	1154	332	655	2.001	922	5.7
1993	1564	2378	772	1174	1.831	290	12.4
1994	1424	2578	516	934	1.844	750	10.6
1995	1206	1799	517	771	1.716	1028	10.2
1996	812	2112	351	913	2.099	1068	11.3

¹ 1981-1996 from Revised Marine Recreational Fishery Statistics Survey database expanded catch estimates.

Table 5. USA sampling of commercial Atlantic cod landings from the Gulf of Maine cod stock (NAFO Division 5Y), 1982 - 1996.

Year	Number of Samples				Number of Samples, by Market Category & Quarter												Annual Sampling Intensity						
	Length Samples		Age Samples		Scrod					Market					Large					No. of Tons Landed/Sample			
	No.	# Fish Measured	No.	# Fish Aged	Q1	Q2	Q3	Q4	Σ	Q1	Q2	Q3	Q4	Σ	Q1	Q2	Q3	Q4	Σ	Scd	Mkt	Lge	Σ
1982	48	3848	48	866	6	7	6	6	25	4	3	7	4	18	0	2	1	2	5	134	348	792	266
1983	71	5241	67	1348	14	10	10	4	38	4	10	6	2	22	1	3	5	2	11	106	294	318	197
1984	55	3925	55	1224	7	5	6	7	25	4	3	5	6	18	1	6	3	2	12	85	319	245	193
1985	69	5426	66	1546	5	6	7	5	23	8	6	7	4	25	7	5	3	6	21	95	229	132	155
1986	53	3970	51	1160	5	5	6	3	19	5	6	8	2	21	1	5	4	3	13	124	242	170	182
1987	43	3184	42	939	4	4	3	4	15	5	5	3	5	18	4	2	3	1	10	83	224	225	175
1988	34	2669	33	741	4	3	4	4	15	1	5	3	5	14	1	2	2	0	5	147	271	391	234
1989	32	2668	32	714	3	3	3	3	12	4	1	5	4	14	2	2	1	1	6	209	430	311	325
1990	39	2982	38	789	3	7	3	5	18	4	7	4	3	18	0	2	1	0	3	300	378	966	387
1991	56	4519	56	1152	2	10	4	3	19	5	11	11	3	30	0	3	3	1	7	250	313	519	318
1992	51	4086	51	1002	2	8	6	3	19	6	7	7	3	23	3	1	1	4	9	104	232	375	214
1993	23	1753	23	447	3	3	3	1	10	1	2	4	1	8	1	1	2	1	5	177	453	527	360
1994	30	2696	33	665	0	2	2	4	8	1	4	4	6	15	0	2	3	2	7	180	284	272	263
1995	31	2568	32	662	4	2	2	4	12	2	7	1	2	12	0	5	0	2	7	133	300	202	219
1996	77	7027	71	1483	6	5	7	9	27	7	9	10	12	38	1	3	3	5	12	62	116	79	93

Source: 1978-1985 from Serchuk and Wigley (Woods Hole Lab. Ref 86-12); 1986-1996 from NEFSC files.

Table 6. Percentage (by weight) of USA commercial Atlantic cod landings from the Gulf of Maine (NAFO Division 5Y), by market category, 1964 - 1996.

Year	Gulf of Maine			
	Large	Market	Scrod	Total [a]
1964	29	59	12	100
1965	39	54	7	100
1966	42	48	10	100
1967	41	41	17	100
1968	47	43	9	100
1969	35	55	9	100
1970	43	52	6	100
1971	52	42	6	100
1972	58	35	7	100
1973	52	36	11	100
1974	39	33	28	100
1975	32	42	26	100
1976	29	45	20	100
1977	33	42	22	100
1978	38	44	17	100
1979	37	49	14	100
1980	36	45	19	100
1981	29	45	22	100
1982	29	45	24	100
1983	25	45	28	100
1984	26	51	19	100
1985	25	51	20	100
1986	22	51	23	100
1987	29	52	16	100
1988	26	45	23	100
1989	17	55	23	100
1990	34	43	19	100
1991	26	51	20	100
1992	31	49	18	100
1993	32	44	21	100
1994	24	54	18	100
1995	21	53	23	100
1996	13	61	23	100

[a] Includes landings of 'mixed' cod.

Table 7a. Catch at age (thousands of fish; metric tons) of total commercial landings of Atlantic cod from the Gulf of Maine stock (NAFO Division 5Y), 1982 - 1996.

Year	Age												Total
	1	2	3	4	5	6	7	8	9	10	11+		
Total Commercial Catch in Numbers (000's) at Age													
1982	30	1380	1633	1143	633	69	91	61	41	4	33		5118
1983	-	866	2357	1058	638	422	47	61	23	9	15		5496
1984	4	446	1240	1500	437	194	74	19	15	11	17		3957
1985	-	407	1445	991	630	128	78	32	4	11	11		3737
1986	-	84	2164	813	250	177	39	24	20	4	8		3583
1987	2	216	595	1109	277	66	51	9	8	8	3		2344
1988	-	160	1443	953	406	43	9	17	1	2	1		3035
1989	-	337	1583	1454	449	81	35	6	3	5	7		3960
1990	-	205	3425	2064	430	157	27	30	10	15	17		6380
1991	-	344	934	4161	851	143	41	30	6	1	1		6512
1992	-	313	530	484	2018	202	62	7	12	3	-		3631
1993	-	76	1487	641	129	457	28	6	2	-	-		2825
1994	-	29	1016	1135	288	72	54	17	13	1	1		2626
1995	-	218	880	1153	194	12	8	22	3	1	-		2491
1996	-	65	584	1738	347	45	5	2	3	-	-		2789
Total Commercial Catch in Weight (Tons) at Age													
1982	24	1595	2717	3160	3019	461	813	608	531	41	613		13582
1983	-	1009	3913	2619	2410	2518	271	643	227	102	269		13981
1984	3	516	2071	4080	1607	1145	603	186	193	152	250		10816
1985	-	513	2523	2816	2814	705	615	363	51	141	152		10693
1986	-	110	3976	2375	1153	1072	296	243	253	54	132		9664
1987	2	283	1001	3641	1340	451	455	88	116	110	40		7527
1988	-	203	2715	2311	2097	295	85	191	11	36	14		7958
1989	-	420	2811	4351	1737	325	323	67	43	87	163		10397
1990	-	219	5794	4687	1834	1200	290	354	153	214	350		15095
1991	-	388	1463	10455	3520	1045	399	369	93	32	17		17781
1992	-	480	1019	1313	6175	1011	594	88	161	49	-		10891
1993	-	99	2809	1611	561	2819	281	79	27	-	-		8286
1994	-	43	1975	3576	991	442	451	218	156	20	6		7877
1995	-	361	1689	3200	997	96	92	291	45	27	-		6798
1996	-	110	1247	4131	1267	333	49	18	39	-	-		7194

Table 7b. Mean weight (kg) and mean length (cm) at age of total commercial landings of Atlantic cod from the Gulf of Maine stock
 (NAFO Division 5Y), 1982 - 1996.

Year	Age												Average
	1	2	3	4	5	6	7	8	9	10	11+		
Total Commercial Catch Mean Weight (kg) at Age													
1982	0.801	1.156	1.664	2.764	4.770	6.739	8.944	9.931	12.922	10.618	18.456		2.654
1983	-	1.164	1.660	2.475	3.778	5.962	5.808	10.522	10.089	10.898	17.813		2.544
1984	0.589	1.159	1.670	2.721	3.677	5.898	8.119	9.595	12.889	13.951	15.028		2.731
1985	-	1.260	1.746	2.840	4.466	5.525	7.901	11.218	11.420	13.386	14.523		2.861
1986	-	1.304	1.837	2.923	4.619	6.067	7.669	10.030	12.463	12.907	16.554		2.697
1987	1.028	1.313	1.684	3.283	4.831	6.824	8.878	10.023	13.752	14.738	14.596		3.211
1988	-	1.268	1.881	2.426	5.166	6.767	9.932	11.126	14.960	15.763	20.356		2.622
1989	-	1.247	1.776	2.993	3.864	4.872	9.267	11.938	14.806	18.196	21.521		2.626
1990	-	1.071	1.692	2.271	4.265	7.645	10.734	11.758	15.015	14.784	20.295		2.366
1991	-	1.130	1.568	2.512	4.136	7.309	9.642	12.322	15.547	24.328	21.885		2.730
1992	-	1.533	1.922	2.714	3.061	5.000	9.566	12.462	13.449	16.631	-		2.999
1993	-	1.293	1.889	2.513	4.356	6.174	9.999	13.869	17.544	-	-		2.933
1994	-	1.450	1.943	3.151	3.444	6.132	8.321	12.628	12.052	21.532	19.369		3.000
1995	-	1.652	1.921	2.775	5.142	8.290	10.755	12.914	16.433	21.504	-		2.729
1996	-	1.687	2.136	2.376	3.648	7.376	10.440	11.928	13.471	-	-		2.579
Total Commercial Catch Mean Length (cm) at Age													
1982	43.2	48.3	53.8	63.4	76.8	86.1	94.6	97.9	107.4	101.0	120.7		59.9
1983	-	48.6	53.8	61.4	70.8	82.4	80.5	98.8	97.5	100.0	118.7		59.8
1984	39.0	48.4	54.1	63.4	69.7	81.8	91.5	96.7	106.9	109.6	112.0		61.6
1985	-	49.8	55.1	64.6	74.9	80.3	90.8	101.9	103.1	108.2	109.7		62.8
1986	-	50.3	55.9	65.0	75.4	82.6	89.9	98.7	105.8	107.5	116.2		61.6
1987	47.0	50.4	54.4	67.8	76.9	86.5	93.8	98.7	109.5	111.7	111.3		65.4
1988	-	50.1	56.4	61.1	78.7	86.4	98.6	102.3	113.0	114.8	125.0		61.4
1989	-	49.8	55.5	65.7	71.5	76.7	95.8	103.4	112.6	120.4	126.8		61.7
1990	-	47.5	54.8	60.0	73.7	90.0	100.9	104.0	111.8	112.6	124.6		59.2
1991	-	47.7	52.6	61.8	72.6	88.6	97.2	105.0	113.3	132.5	128.0		62.2
1992	-	53.1	56.6	62.9	65.6	77.0	97.3	106.1	109.1	117.0	-		64.3
1993	-	50.5	56.8	61.7	74.2	83.7	98.6	110.0	119.1	-	-		63.5
1994	-	52.4	57.2	66.6	68.1	82.7	92.0	106.4	104.9	127.3	123.0		64.4
1995	-	54.4	56.9	63.4	78.6	92.5	101.1	107.2	116.1	127.2	-		62.3
1996	-	54.6	58.8	60.7	69.3	88.9	99.9	104.8	108.7	-	-		61.8

Table 8a. Catch at age (thousands of fish; metric tons) of total commercial landings of Atlantic cod from the Gulf of Maine stock (NAFO Division 5Y), 1982 - 1996.
 (Input data for Virtual Population Analysis).

Year	Age							Total
	1	2	3	4	5	6	7+	
Total Commercial Catch in Numbers (000's) at Age								
1982	30	1380	1633	1143	633	69	230	5118
1983	-	866	2357	1058	638	422	155	5496
1984	4	446	1240	1500	437	194	136	3957
1985	-	407	1445	991	630	128	136	3737
1986	-	84	2164	813	250	177	95	3583
1987	2	216	595	1109	277	66	79	2344
1988	-	160	1443	953	406	43	30	3035
1989	-	337	1583	1454	449	81	56	3960
1990	-	205	3425	2064	430	157	99	6380
1991	-	344	934	4161	851	143	79	6512
1992	-	313	530	484	2018	202	84	3631
1993	-	76	1487	641	129	457	36	2825
1994	-	29	1016	1135	288	72	86	2626
1995	-	218	880	1153	194	12	34	2491
1996	-	65	584	1738	347	45	10	2789
Total Commercial Catch in Weight (Tons) at Age								
1982	24	1595	2717	3160	3019	461	2606	13582
1983	-	1009	3913	2619	2410	2518	1512	13981
1984	3	516	2071	4080	1607	1145	1384	10816
1985	-	513	2523	2816	2814	705	1322	10693
1986	-	110	3976	2375	1153	1072	978	9664
1987	2	283	1001	3641	1340	451	809	7527
1988	-	203	2715	2311	2097	295	337	7958
1989	-	420	2811	4351	1737	325	683	10397
1990	-	219	5794	4687	1834	1200	1361	15095
1991	-	388	1463	10455	3520	1045	910	17781
1992	-	480	1019	1313	6175	1011	892	10891
1993	-	99	2809	1611	561	2819	387	8286
1994	-	43	1975	3576	991	442	851	7877
1995	-	361	1689	3200	997	96	455	6798
1996	-	110	1247	4131	1267	333	106	7194

Table 8b. Mean weight (kg) and mean length (cm) at age of total commercial landings of Atlantic cod from the Gulf of Maine stock (NAFO Division 5Y), 1982 - 1996.
 (Input data for Virtual Population Analysis)

Year	Age							Average
	1	2	3	4	5	6	7+	
Total Commercial Catch Mean Weight (kg) at Age								
1982	0.801	1.156	1.664	2.764	4.770	6.739	11.330	2.654
1983	-	1.164	1.660	2.475	3.778	5.962	9.755	2.544
1984	0.589	1.159	1.670	2.721	3.677	5.898	10.176	2.731
1985	-	1.260	1.746	2.840	4.466	5.525	9.721	2.861
1986	-	1.304	1.837	2.923	4.619	6.067	10.295	2.697
1987	1.028	1.313	1.684	3.283	4.831	6.824	10.241	3.211
1988	-	1.268	1.881	2.426	5.166	6.767	11.233	2.622
1989	-	1.247	1.776	2.993	3.864	4.872	12.200	2.626
1990	-	1.071	1.692	2.271	4.265	7.645	13.747	2.366
1991	-	1.130	1.568	2.512	4.136	7.309	11.449	2.730
1992	-	1.533	1.922	2.714	3.061	5.000	10.614	2.999
1993	-	1.293	1.889	2.513	4.353	6.174	11.063	2.933
1994	-	1.450	1.943	3.151	3.444	6.132	10.018	3.000
1995	-	1.652	1.921	2.775	5.142	8.290	12.969	2.729
1996	-	1.687	2.136	2.376	3.648	7.376	11.647	2.579
Total Commercial Catch Mean Length (cm) at Age								
1982	43.2	48.3	53.8	63.4	76.8	86.1	101.6	59.9
1983	-	48.6	53.8	61.4	70.8	82.4	95.1	59.8
1984	39.0	48.4	54.1	63.4	69.7	81.8	98.0	61.6
1985	-	49.8	55.1	64.6	74.9	80.3	96.7	62.8
1986	-	50.3	55.9	65.0	75.4	82.6	98.4	61.6
1987	47.0	50.4	54.4	67.8	76.9	86.5	98.4	65.4
1988	-	50.1	56.4	61.1	78.7	86.4	103.1	61.4
1989	-	49.8	55.5	65.7	71.5	76.7	103.6	61.7
1990	-	47.5	54.8	60.0	73.7	90.0	108.8	59.2
1991	-	47.7	52.6	61.8	72.6	88.6	102.2	62.2
1992	-	53.1	56.6	62.9	65.6	77.0	100.4	64.3
1993	-	50.5	56.8	61.7	74.2	83.7	101.6	63.5
1994	-	52.4	57.2	66.6	68.1	82.7	97.6	64.4
1995	-	54.4	56.9	63.4	78.6	92.5	107.1	62.3
1996	-	54.6	58.8	60.7	69.3	88.9	103.5	61.8

Table 9. Mean weight at age (kg) at the beginning of the year (January 1) for Atlantic cod from the Gulf of Maine stock (NAFO Division 5Y), 1982 - 1996. Values derived from commercial landings mean weight-at-data (mid-year) using procedures described by Rivard (1980).

Year	Age									
	1	2	3	4	5	6	7	8	9	10+ [a]
1982	0.791	0.965	1.364	2.364	(3.750)	(5.600)	(7.400)	9.853	(11.650)	17.771
1983	0.793	1.024	1.385	2.029	3.231	5.333	6.256	9.701	10.010	17.771
1984	0.761	1.021	1.394	2.125	3.017	4.720	6.957	(9.670)	11.646	17.771
1985	0.748	1.065	1.423	2.178	3.486	4.507	6.826	9.544	10.468	17.771
1986	0.745	1.083	1.521	2.259	3.622	5.205	6.509	8.902	11.824	17.771
1987	0.758	1.087	1.482	2.456	3.758	5.614	7.339	8.767	11.744	17.771
1988	0.765	1.068	1.572	2.021	4.118	5.718	8.233	9.939	12.245	17.771
1989	0.825	1.059	1.501	2.373	3.062	5.017	7.919	10.889	12.835	17.771
1990	0.803	0.982	1.453	2.008	3.573	5.435	7.232	10.438	13.388	17.771
1991	0.690	1.008	1.296	2.062	3.065	5.583	8.586	11.501	13.520	17.771
1992	0.751	1.175	1.474	2.063	2.773	4.548	8.362	10.962	12.873	17.771
1993	0.709	1.079	1.702	2.198	3.438	4.347	7.071	11.518	14.786	17.771
1994	0.664	1.142	1.585	2.440	2.942	5.168	7.168	11.237	12.929	17.771
1995	0.657	1.219	1.669	2.322	4.025	5.343	8.113	10.366	14.405	17.771
1996	0.657	1.232	1.878	2.136	3.182	6.159	9.303	11.316	13.190	17.771
Mean Values										
1992-96	0.688	1.169	1.662	2.232	3.272	5.113	8.003	11.080	13.637	17.771
1982-96	0.741	1.081	1.513	2.202	3.437	5.330	7.608	10.160	12.479	17.771

[a] Mean weight-at-age values for 10+ set equal to mean (1982-1996) catch (mid-year) weight at age value for 10+.

() Values in parentheses are modified from calculated values.

Table 10a. Catch at age (thousands of fish; metric tons) of total recreational landings of Atlantic cod from the Gulf of Maine stock (NAFO Division 5Y), 1982 - 1996.
 (Partial input data for trial Virtual Population Analysis)

Year	Age							Total
	1	2	3	4	5	6	7+	
Total Recreational Catch in Numbers (000's) at Age								
1982	58	615	717	243	84	6	12	1735
1983	14	471	539	126	47	26	14	1237
1984	20	367	332	136	32	11	6	904
1985	49	582	666	131	35	5	1	1469
1986	26	124	586	116	25	20	95	992
1987	39	691	823	416	53	13	18	2053
1988	6	360	697	196	28	8	4	1299
1989	5	193	701	244	36	10	5	1194
1990	7	89	770	309	58	10	6	1249
1991	5	103	415	787	95	8	6	1419
1992	-	37	70	42	166	14	2	331
1993	1	76	511	146	11	24	3	772
1994	1	28	364	93	27	2	2	517
1995	-	61	272	171	10	2	-	516
1996	-	21	104	205	21	1	-	352
Total Recreational Catch in Weight (Tons) at Age								
1982	26	556	1018	559	373	33	132	2697
1983	6	412	751	272	158	173	168	1940
1984	9	304	480	332	103	47	78	1353
1985	18	494	899	305	115	20	5	1856
1986	11	103	970	304	99	114	1247	2848
1987	11	634	1184	1111	224	96	189	3449
1988	1	310	1049	425	107	26	26	1944
1989	3	208	1111	628	124	61	43	2178
1990	1	80	1147	727	212	66	63	2296
1991	1	119	582	1749	287	48	34	2820
1992	-	56	130	119	509	69	19	902
1993	1	73	841	292	33	108	41	1389
1994	-	35	593	214	56	7	17	922
1995	-	91	443	331	36	4	-	905
1996	-	32	193	406	54	7	3	695

Table 10b. Mean weight (kg) and mean length (cm) at age of total recreational landings of Atlantic cod from the Gulf of Maine stock (NAFO Division 5Y), 1982 - 1996.
 (Partial input data for trial Virtual Population Analysis)

Year	Age							Average
	1	2	3	4	5	6	7+	
Total Recreational Catch Mean Weight (kg) at Age								
1982	0.452	0.904	1.420	2.297	4.417	5.542	10.872	1.554
1983	0.410	0.874	1.394	2.159	3.350	6.635	12.136	1.568
1984	0.450	0.827	1.447	2.432	3.236	4.215	11.892	1.497
1985	0.371	0.848	1.349	2.330	3.298	3.780	5.2091	1.263
1986	0.413	0.832	1.655	2.630	3.884	5.600	12.995	2.871
1987	0.269	0.918	1.439	2.672	4.252	7.134	10.283	1.680
1988	0.184	0.860	1.504	2.165	3.816	3.443	6.067	1.497
1989	0.615	1.081	1.586	2.575	3.498	6.285	7.851	1.824
1990	0.148	0.900	1.489	2.354	3.640	6.587	13.783	1.838
1991	0.171	1.156	1.403	2.223	3.013	5.696	5.696	1.987
1992	0.456	1.495	1.858	2.832	3.074	4.820	7.221	2.725
1993	0.582	0.959	1.645	2.001	3.131	4.566	11.797	1.799
1994	0.183	1.240	1.632	2.302	2.046	4.613	8.947	1.783
1995	-	1.501	1.627	1.931	3.404	1.871	6.062	1.754
1996	0.582	1.541	1.853	1.979	2.706	7.829	12.378	1.974
Total Recreational Catch Mean Length (cm) at Age								
1982	33.9	42.9	50.2	59.0	74.1	79.9	98.4	59.9
1983	33.5	42.9	50.1	57.9	67.1	84.5	101.2	59.8
1984	34.2	42.0	50.5	60.1	66.1	71.0	100.1	61.6
1985	32.0	42.4	49.3	60.0	67.0	70.1	78.9	62.8
1986	33.7	41.6	53.3	62.0	70.8	80.4	113.4	61.6
1987	27.8	43.4	50.5	62.5	72.3	86.0	98.6	65.4
1988	26.2	42.8	51.3	58.2	69.9	66.2	81.3	61.4
1989	38.4	46.2	52.5	61.6	67.8	83.9	97.5	61.7
1990	23.7	43.1	51.1	59.8	69.7	84.4	110.0	59.2
1991	24.9	47.0	50.4	58.5	64.5	80.0	80.9	62.2
1992	35.0	51.3	54.7	63.1	64.9	75.4	86.6	64.3
1993	38.0	44.3	53.2	56.6	64.9	72.8	103.1	63.5
1994	26.3	48.2	53.2	59.1	57.2	71.7	95.1	64.4
1995	-	51.8	53.2	55.9	67.1	55.1	83.0	62.3
1996	38.0	52.3	55.4	56.6	62.0	90.1	106.3	61.8

Table 11. Percentage, within vessel tonnage class¹, of Atlantic cod otter-trawl landings (L)², vessel trips (T), and effort (DF)³ from the Gulf of Maine (NAFO Division 5Y) accounted for by otter-trawl trips in which cod comprised 50% or more of the total trip catch, by weight ['directed trips'], 1965 - 1993.

Year	Class 2			Class 3			Class 4			Totals		
	L	T	DF	L	T	DF	L	T	DF	L	T	DF
1965	27.9	9.2	14.6	33.2	10.1	7.7	2.2	3.3	1.1	29.5	9.3	12.5
1966	20.0	5.2	<0.1	30.1	9.0	9.0	10.6	5.3	4.8	24.0	5.9	10.0
1967	36.6	10.7	30.2	51.3	18.1	21.9	0.9	1.0	0.5	43.9	12.3	25.7
1968	35.7	10.8	24.3	50.9	19.4	17.7	22.8	7.1	8.8	42.4	12.9	21.6
1969	46.8	17.5	42.4	48.2	21.8	19.5	18.9	8.1	11.3	45.0	18.4	33.7
1970	40.8	16.0	28.3	35.8	13.7	9.1	11.8	5.1	3.5	37.1	15.0	22.2
1971	35.4	14.1	25.8	31.3	15.2	8.4	25.3	3.4	5.7	33.4	13.9	20.0
1972	28.4	12.5	15.1	22.0	10.1	5.4	24.0	6.9	4.5	25.7	11.8	12.0
1973	18.8	7.6	9.7	8.2	4.4	2.3	0.5	1.4	0.4	14.1	6.7	7.4
1974	20.4	9.5	11.8	25.1	7.7	6.3	39.5	8.8	8.4	24.2	9.2	10.2
1975	33.7	12.3	23.7	40.0	15.2	12.8	21.2	5.6	3.8	35.8	12.7	19.5
1976	37.8	11.7	27.2	40.6	19.8	14.7	8.4	2.6	1.1	38.0	13.4	21.5
1977	36.4	10.5	31.9	46.8	19.5	13.6	12.9	3.4	1.0	40.4	12.8	23.3
1978	34.1	9.9	26.0	41.2	16.0	11.3	9.8	1.4	0.9	35.6	10.9	19.1
1979	29.9	9.7	19.8	38.9	18.6	11.8	9.7	2.2	0.9	32.4	11.4	16.0
1980	30.2	9.4	19.2	34.5	16.1	8.9	17.3	3.0	2.4	31.1	10.9	14.5
1981	42.6	10.5	32.3	37.4	13.5	8.3	13.3	3.4	1.5	37.6	11.1	20.4
1982	37.4	10.4	22.2	51.4	17.9	11.5	26.1	5.1	3.7	42.5	12.3	16.1
1983	40.3	12.2	25.4	53.5	23.9	12.7	16.9	5.4	1.6	43.8	15.6	16.9
1984	21.8	6.1	3.9	29.3	9.4	6.2	2.4	0.2	0.3	22.9	7.0	4.4
1985	24.3	6.4	5.5	29.6	9.2	5.4	13.5	2.8	2.5	24.6	7.1	4.9
1986	24.3	4.9	5.3	19.5	6.5	4.8	9.5	2.3	1.6	18.3	5.3	4.3
1987	22.4	4.0	3.8	13.6	4.0	3.2	7.8	2.5	1.5	14.6	3.9	3.1
1988	32.1	6.4	7.2	43.8	11.5	10.1	16.4	4.7	3.5	34.9	8.3	7.8
1989	53.2	13.5	14.8	54.7	21.4	21.1	32.6	15.8	14.9	49.2	16.7	17.7
1990	63.1	17.6	21.5	71.7	35.4	33.6	62.7	43.9	40.1	67.1	26.7	30.3
1991	68.7	27.3	29.3	71.1	37.1	39.6	73.0	56.9	55.7	71.3	33.0	39.2
1992	58.2	21.2	19.4	59.5	21.0	21.2	30.0	20.0	13.5	51.2	21.1	19.2
1993	37.6	13.0	10.8	54.0	17.3	16.4	33.0	15.5	13.2	45.1	14.9	14.1

¹ Class 2: 5-50 GRT; Class 3: 51-150 GRT; Class 4: 151-500 GRT.

² Metric tons, live weight.

³ Effort expressed as days fished with trawl on bottom; derived by dividing hours fished with trawl on bottom by 24.

Table 12. Total and USA commercial landings, USA catch-per-unit of effort indices (CPUE: all cod trips), and derived effort indices for Gulf of Maine cod, 1965 - 1993.

Year	Total Landings (mt)	USA Landings (mt)	USA CPUE Index (All Cod Trips)	Total Calculated Days Fished	USA Calculated Days Fished
1965	3928	3780	0.6954	5649	5436
1966	4392	4008	0.8510	5161	4710
1967	5973	5676	1.4096	4237	4027
1968	6421	6360	1.1273	5696	5642
1969	8484	8157	1.4241	5957	5728
1970	8261	7812	0.8871	9312	8806
1971	7662	7380	0.8815	8692	8372
1972	6917	6776	0.6800	10172	9965
1973	6146	6069	0.6382	9630	9510
1974	7764	7639	1.0207	7607	7484
1975	9015	8903	1.0220	8821	8711
1976	10188	10172	1.0842	9397	9382
1977	12426	12426	1.2094	10275	10275
1978	12426	12426	0.9712	12794	12794
1979	11680	11680	0.9361	12477	12477
1980	13528	13528	0.8346	16209	16209
1981	12534	12534	0.8561	14641	14641
1982	13582	13582	0.8395	16179	16179
1983	13981	13981	0.8466	16514	16514
1984	10806	10806	0.5410	19974	19974
1985	10693	10693	0.5219	20489	20489
1986	9664	9664	0.4630	20873	20873
1987	7527	7527	0.3056	24630	24630
1988	7958	7958	0.3498	22750	22750
1989	10397	10397	0.5561	18696	18696
1990	15154	15154	1.0279	14743	14743
1991	17781	17781	1.1054	16086	16086
1992	10891	10891	0.5470	19910	19910
1993	8287	8287	0.4327	19152	19152

Table 13. Results of fishing effort standardization for Gulf of Maine cod using SAS General Linear Models Procedure on landings and effort data from 1982 through 1993.

General Linear Models Procedure					
Dependent Variable: LNCPUEDF					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	25	11590.71659123	463.62866365	297.95	0.000
Error	24312	37830.50628931	1.55604254		
Corrected Total	24337	49421.22288055			
	R-Square	C.V.	Root MSE	LNCPUEDF Mea	
	0.234529	-112.2323	1.24741434	-1.1114573	
Source	DF	Type I SS	Mean Square	F Value	Pr > F
YEAR	11	4833.96208197	439.45109836	282.42	0.000
AREA	4	164.54673741	41.13668435	26.44	0.000
QTR	3	1191.97998989	397.32666330	255.34	0.000
TONCLASS	4	3340.33653032	835.08413258	536.67	0.000
DEPTHCD	3	2059.89125164	686.63041721	441.27	0.000
Source	DF	Type III SS	Mean Square	F Value	Pr > F
YEAR	11	4372.73212998	397.52110273	255.47	0.000
AREA	4	302.41968487	75.60492122	48.59	0.000
QTR	3	1241.37073929	413.79024643	265.92	0.000
TONCLASS	4	4005.54777969	1001.38694492	643.55	0.000
DEPTHCD	3	2059.89125164	686.63041721	441.27	0.000
Parameter	T for H0:		Pr > |T|	Std Error of Estimate	Retransformed Estimate
INTERCEPT	Estimate		Parameter=0		
AREA 511	-0.975002369 B		-23.16	0.0001	0.04210412
512	0.314761808 B		5.46	0.0001	0.05768044
513	0.076641989 B		2.22	0.0262	0.03448159
515	0.259103053 B		10.62	0.0001	0.02440657
514	-0.021602360 B		-0.71	0.4778	0.03043501
QTR 1	0.000000000 B		.	.	0.979083
3	-0.443624023 B		-18.41	0.0001	0.641893
4	-0.572620753 B		-25.38	0.0001	0.02255770
2	-0.496972511 B		-22.60	0.0001	0.564189
TONCLASS 31	0.000000000 B		.	.	0.608517
32	0.452176751 B		18.79	0.0001	1.000000
33	0.867362374 B		35.22	0.0001	0.02409136
41	0.928431872 B		34.51	0.0001	0.02255770
25	1.357558269 B		46.92	0.0001	0.02690090
DEPTHCD 1	0.000000000 B		.	.	2.531454
2	0.631312591 B		20.09	0.0001	0.02893149
4	0.360688553 B		14.82	0.0001	0.02433859
3	-0.647192169 B		-25.11	0.0001	1.434742
	0.000000000 B		.	.	0.523688
			.	.	1.000000

Table 14. Nominal and standardized (GLM) Gulf of Maine cod landings (mt), effort (days fished) and landings per day fished (LPUE) for the otter trawl effort standardization fleet, 1982-1996.

Year	Landings (mt)	Effort Standardization Subfleet Summary Results				Total Landings (mt)	Raised Effort
		Nominal		Standardized			
		Effort	LPUE	Effort	LPUE		
1982	3395	3158	1.075	6042	0.562	13582	24167
1983	3698	3791	0.975	7069	0.523	13981	26730
1984	2423	3798	0.638	6700	0.362	10806	29881
1985	3012	5294	0.569	9985	0.302	10693	35446
1986	2794	5568	0.502	10280	0.272	9664	35558
1987	1708	5100	0.335	9618	0.178	7527	42392
1988	2060	4753	0.433	9552	0.216	7958	36898
1989	2316	3524	0.657	7363	0.314	10397	33061
1990	4916	4053	1.213	9020	0.545	15154	27807
1991	5432	4737	1.147	10139	0.536	17781	33188
1992	2777	4978	0.558	9637	0.288	10891	37795
1993	2284	4727	0.483	8605	0.265	8287	31219
1994*	1160	5005	0.232	9034	0.128	7877	61357
1995*	1829	7215	0.254	14002	0.131	6798	52031
1996*	2065	6695	0.308	11930	0.173	7194	41558

* 1982-1993 data from interviews; 1994-1996 data from Vessel Trip Reports

Table 15. Standardized stratified mean catch per tow in numbers and weight (kg) for Atlantic cod from NEFSC offshore spring and autumn research vessel bottom trawl surveys in the Gulf of Maine (Strata 26-30 and 36-40), 1963 - 1996 [a,b]

Year	Gulf of Maine [c]			
	Spring		Autumn	
	No/Tow	Wt/Tow	No/Tow	Wt/Tow
1963	-	-	5.92	17.9
1964	-	-	4.00	22.8
1965	-	-	4.49	12.0
1966	-	-	3.78	12.9
1967	-	-	2.56	9.2
1968	5.44	17.9	4.39	19.4
1969	3.25	13.2	2.76	15.4
1970	2.21	11.1	4.90	16.4
1971	1.43	7.0	4.37	16.5
1972	2.06	8.0	9.31	13.0
1973	7.54	18.8	4.46	8.7
1974	2.91	7.4	4.33	9.0
1975	2.51	6.0	6.15	8.6
1976	2.78	7.6	2.15	6.7
1977	3.88	8.5	3.08	10.2
1978	2.06	7.7	5.75	12.9
1979	4.27	9.5	3.49	17.5
1980	2.15	6.2	7.04	14.2
1981	4.86	10.8	2.42	8.1
1982	3.75	8.6	7.77	16.1
1983	3.91	10.5	4.22	8.8
1984	3.40	5.8	2.42	8.8
1985	2.52	7.7	2.92	8.5
1986	1.96	3.6	1.95	5.1
1987	1.68	3.0	2.98	3.4
1988	3.13	3.3	5.90	6.6
1989	2.26	2.5	4.65	4.6
1990	2.36	3.1	2.99	4.9
1991	2.39	2.9	1.25	2.8
1992	2.41	8.7	1.43	2.4
1993	2.50	5.9	1.23	1.0
1994	1.27	2.4	2.14	2.7
1995	1.91	2.4	2.01	3.7
1996	2.46	5.4	1.32	2.4

[a] During 1963-1984, BMV oval doors were used in the spring and autumn surveys; since 1985, Portuguese polyvalent doors have been used in both surveys. Adjustments have been made to the 1963-1984 catch per tow data to standardize these data to polyvalent door equivalents. Conversion coefficients of 1.56 (numbers) and 1.62 (weight) were used in this standardization (NEFSC 1991).

[b] Spring surveys during 1973-1981 were accomplished with a '41 Yankee' trawl; in all other years, spring surveys were accomplished with a '36 Yankee' trawl. No adjustments have been made to the catch per tow data for these differences.

[c] In the Gulf of Maine, spring surveys during 1980-1982, 1989-1991 and 1994, and autumn surveys during 1977-1978, 1980, 1989-1991 and 1993 were accomplished with the R/V DELAWARE II; in all other years, the surveys were accomplished using the R/V ALBATROSS IV. Adjustments have been made to the R/V DELAWARE II catch per tow data to standardize these to R/V ALBATROSS IV equivalents. Conversion coefficients 0.79 (number) and 0.67 (weight) were used in this standardization (NEFC 1991).

Table 16. Estimates of instantaneous total mortality (Z) and fishing mortality (F)¹ for Gulf of Maine Atlantic cod for eight time periods, 1964 - 1993, derived from NEFSC offshore spring and autumn bottom trawl survey data.²

Time Period	Gulf of Maine					
	Spring		Autumn		Geometric Mean	
	Z	F	Z	F	Z	F
1964-1967	-	-	0.39	0.19	0.39	0.19
1968-1972	0.37 ³	0.17	0.43 ⁷	0.23	0.40	0.20
1973-1976	0.35 ⁴	0.15	0.45	0.25	0.40	0.20
1977-1981	0.52	0.32	0.57 ⁸	0.37	0.54	0.34
1982-1984	0.73	0.53	0.78	0.58	0.75	0.55
1985-1987	0.58 ⁵	0.38	1.05	0.85	0.78	0.58
1988-1990	1.24	1.04	0.72	0.61	0.94	0.74
1991-1993	1.02 ⁶	0.82	1.18	0.98	1.10	0.90
1994-1996	1.31	1.11	0.94	0.74	1.11	0.91

¹ Instantaneous natural mortality (M) assumed to be 0.20.

² Estimates derived from:

Spring: $\ln(\sum \text{age } 4+ \text{ for year } i \text{ to } j / \sum \text{age } 5+ \text{ for years } i+1 \text{ to } j+1)$.
 Autumn: $\ln(\sum \text{age } 3+ \text{ for years } i-1 \text{ to } j-1 / \sum \text{age } 4+ \text{ for years } i \text{ to } j)$.

³ Excludes spring 1972-1973 data (4+/5+) since these gave large negative Z value.

⁴ Excludes spring 1973-1974 data (4+/5+) since these gave unreasonably high Z value.

⁵ Excludes spring 1985-1986 data (4+/5+) since these gave unreasonably high Z value.

⁶ Excludes spring 1991-1992 data (4+/5+) since these gave unreasonably low Z value.

⁷ Excludes autumn 1967-1968 data (3+/4+) since these gave large negative Z value.

⁸ Excludes autumn 1976-1977 data (3+/4+) since these gave large negative Z value.

Table 17. Summary statistics of the base, alternative, and final ADAPT VPA calibration for Gulf of Maine cod; terminal year 1996.

ADAPT Run Number 361 1997 4 16 9 8 15					
COD: GULF OF MAINE STOCK - COMMERCIAL LANDINGS ONLY FINAL CALIBRATION RUN					
ALL INDICES UNWEIGHTED; NO TIME TAPERED WEIGHTING APPLIED 7+CAA					
PAR. EST.	STD. ERR.	T-STATISTIC	C.V.	1996 F Estimate	
N 2	7.21262E2	3.29056E2	2.19191E0	0.46	F 2 0.08
N 3	7.30254E2	2.24368E2	3.25471E0	0.31	F 3 0.33
N 4	1.36997E3	4.25191E2	3.22201E0	0.31	F 4 0.82
N 5	1.24398E3	5.05247E2	2.46212E0	0.41	F 5 1.25
N 6	1.25367E2	7.18052E1	1.74593E0	0.57	F 6 1.04
				F 7+	1.04

ADAPT Run Number 358 1997 4 17 14 1 58					
COD: GULF OF MAINE STOCK - COMMERCIAL LANDINGS ONLY					
ALL INDICES UNWEIGHTED; NO TIME TAPERED WEIGHTING APPLIED FULL CAA 2-10+					
PAR. EST.	STD. ERR.	T-STATISTIC	C.V.	1996 F Estimate	
N 2	7.24209E2	3.29251E2	2.19956E0	0.45	F 2 0.08
N 3	7.33445E2	2.24515E2	3.26680E0	0.31	F 3 0.32
N 4	1.38003E3	4.26110E2	3.23868E0	0.31	F 4 0.77
N 5	1.34525E3	5.28603E2	2.54492E0	0.39	F 5 1.20
N 6	1.34433E2	7.58129E1	1.77322E0	0.56	F 6 0.99
				F 7	0.99
				F 8	0.99
				F 9	0.99
				F 10+	0.99

ADAPT Run Number 356 1997 4 8 11 10 48					
COD: GULF OF MAINE STOCK - COMMERCIAL AND RECREATIONAL LANDINGS					
ALL INDICES UNWEIGHTED; NO TIME TAPERED WEIGHTING APPLIED 7+CAA					
PAR. EST.	STD. ERR.	T-STATISTIC	C.V.	1996 F Estimate	
N 2	9.05232E2	4.16297E2	2.17449E0	0.46	F 2 0.07
N 3	9.14172E2	2.82058E2	3.24108E0	0.31	F 3 0.29
N 4	1.73550E3	5.27683E2	3.28890E0	0.30	F 4 0.73
N 5	1.54337E3	6.06747E2	2.54368E0	0.39	F 5 1.20
N 6	1.40041E2	7.99724E1	1.75112E0	0.57	F 6 0.97
				F 7+	0.97

ADAPT Run Number 360 1997 4 9 12 6 32					
COD: GULF OF MAINE STOCK - COMMERCIAL AND RECREATIONAL					
ALL INDICES UNWEIGHTED; NO TIME TAPERED WEIGHTING APPLIED ESTIMATING AGE 1; ADDED AGE 1 INDICES FROM MASS SURVEYS 7+CAA					
PAR. EST.	STD. ERR.	T-STATISTIC	C.V.	1996 F Estimate	
N 1	6.45573E3	4.79997E3	1.34495E0	0.74	F 1 0.00
N 2	1.14175E3	4.25627E2	2.68251E0	0.37	F 2 0.04
N 3	1.83336E3	5.33715E2	3.43509E0	0.29	F 3 0.22
N 4	2.40028E3	7.09920E2	3.38106E0	0.30	F 4 0.72
N 5	1.57653E3	6.69826E2	2.35364E0	0.42	F 5 1.20
N 6	1.39938E2	9.11111E1	1.53591E0	0.65	F 6 0.96
				F 7+	0.96

Table 18. Estimates of beginning year stock size (thousands of fish), instantaneous fishing mortality (F) and spawning stock biomass (tons) for Gulf of Maine cod derived from virtual population analysis (VPA) calibrated using the ADAPT procedure, 1982-1996.

STOCK NUMBERS (Jan 1) in thousands - GMCOD97																		
	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997		
1 ■	6162	5534	7746	4913	7410	9954	21645	3373	3391	5847	5294	7758	3753	1177	881	---		
2 ■	9108	5018	4530	6339	4023	6067	8148	17721	2761	2776	4787	4334	6352	3073	964	721		
3 ■	4328	6208	3325	3306	4821	3218	4772	6526	14204	2075	1961	3636	3480	5174	2319	730		
4 ■	2666	2066	2950	1600	1399	1989	2096	2601	3911	8530	854	1126	1631	1930	3440	1370		
5 ■	1661	1149	734	1058	413	410	625	854	814	1334	3219	261	342	309	537	1244		
6 ■	166	787	363	206	296	112	85	145	293	277	322	810	97	20	77	125		
7+■	547	284	250	214	156	132	58	98	182	151	131	63	113	54	17	27		
1+■	24639	21046	19900	17636	18518	21881	37428	31318	25555	20990	16569	17988	15769	11737	8234	---		
2+■	18477	15512	12154	12723	11108	11927	15783	27945	22164	15143	11275	10230	12016	10560	7353	4218		

FISHING MORTALITY - GMCOD97

LIVING MORTALITY, GERMANY																	Geo. Mean 1994-96
■	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996		
1 ■	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000
2 ■	0.18	0.21	0.12	0.07	0.02	0.04	0.02	0.02	0.09	0.15	0.08	0.02	0.01	0.08	0.08	0.08	0.040
3 ■	0.54	0.54	0.53	0.66	0.69	0.23	0.41	0.31	0.31	0.69	0.35	0.60	0.39	0.21	0.33	0.300	
4 ■	0.64	0.83	0.83	1.15	1.03	0.96	0.70	0.96	0.88	0.77	0.98	0.99	1.47	1.08	0.82	1.092	
5 ■	0.55	0.95	1.07	1.07	1.10	1.37	1.26	0.87	0.88	1.22	1.18	0.79	2.66	1.19	1.25	1.582	
6 ■	0.61	0.90	0.89	1.16	1.08	1.05	0.82	0.97	0.90	0.84	1.18	0.98	1.71	1.13	1.04	1.262	
7+■	0.61	0.90	0.89	1.16	1.08	1.05	0.82	0.97	0.90	0.84	1.18	0.98	1.71	1.13	1.04	1.262	
4-5 ■	0.60	0.89	0.95	1.11	1.07	1.17	0.98	0.91	0.88	0.99	1.08	0.89	2.07	1.14	1.04	1.344	

SSB AT THE START OF THE SPAWNING SEASON : males & females (MT)

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1 ■	330	297	399	142	214	292	640	108	237	351	346	479	217	67	50
2 ■	2143	1247	1141	3096	2015	3041	4026	8685	620	634	1289	1082	1683	858	272
3 ■	3185	4634	2503	3871	6012	4217	6438	8542	10234	1252	1423	2923	2700	4357	2155
4 ■	4820	3105	4650	2781	2575	4028	3647	5085	5317	12109	1171	1644	2442	2932	5025
5 ■	6070	2972	1738	2983	1204	1184	2017	2187	2284	3033	6666	716	587	927	1259
6 ■	823	3496	1429	739	1245	511	409	597	1298	1274	1141	2834	358	82	379
7+■	5405	2311	2127	1666	1290	1103	566	985	2076	1451	1107	570	822	564	159
1+■	22775	18062	13988	15277	14557	14377	17744	26188	22067	20104	13144	10248	8810	9786	9299
2+■	22445	17765	13589	15135	14343	14085	17104	26080	21830	19753	12798	9769	8593	9719	9249

PERCENT MATURE (females) - GMCD97

Table 19. Results of retrospective analysis of Gulf of Maine cod VPA based on final ADAPT formulation.

A: Recruitment at age 2

STOCK NUMBERS (Jan 1) in thousands - GMCOD97_RETRO

Term Yr	■ 1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1991	■ 9107	5017	4530	6333	4011	5984	8086	16868	3555	2680	4024					
1992	■ 9108	5018	4531	6339	4027	6069	8189	17742	2783	2741	4473	5090				
1993	■ 9108	5018	4531	6339	4024	6067	8156	17728	2827	2553	4213	4329	4221			
1994	■ 9108	5018	4531	6339	4025	6072	8162	17843	2776	2900	4821	4683	5345	3910		
1995	■ 9108	5018	4530	6339	4023	6067	8151	17738	2776	2782	4977	4370	5776	3623	723	
1996	■ 9108	5018	4530	6339	4023	6067	8148	17721	2761	2776	4787	4333	6350	3071	964	721

B: Average (ages 4-5) unweighted F

FISHING MORTALITY - GMCOD97_RETRO

Term Yr	■ 1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1991	■ 0.59	0.89	0.95	1.11	1.07	1.17	0.99	0.94	0.93	1.07					
1992	■ 0.59	0.89	0.95	1.11	1.07	1.17	0.98	0.91	0.87	0.98	1.06				
1993	■ 0.59	0.89	0.95	1.11	1.07	1.17	0.98	0.92	0.87	0.99	1.04	0.97			
1994	■ 0.59	0.89	0.95	1.11	1.07	1.17	0.98	0.91	0.87	0.99	1.05	0.82	1.46		
1995	■ 0.59	0.89	0.95	1.11	1.07	1.17	0.98	0.92	0.88	1.00	1.07	0.87	1.89	0.89	
1996	■ 0.59	0.89	0.95	1.11	1.07	1.17	0.98	0.92	0.88	1.00	1.08	0.89	2.06	1.13	1.04

C: Spawning Stock Biomass

SSB AT THE START OF THE SPAWNING SEASON - males & females (MT)

Term Yr	■ 1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1991	■ 22775	18061	13986	15271	14537	14304	17547	25532	21397	18983					
1992	■ 22776	18062	13988	15278	14560	14386	17776	26259	22158	20192	13296				
1993	■ 22775	18062	13988	15277	14558	14379	17751	26207	22083	20073	12968	9516			
1994	■ 22775	18062	13988	15278	14559	14384	17767	26280	22194	20338	13527	10757	9318		
1995	■ 22775	18062	13988	15277	14557	14379	17749	26204	22089	20158	13262	10431	9168	10099	
1996	■ 22775	18062	13988	15277	14557	14377	17744	26188	22067	20104	13143	10247	8808	9782	9292

Table 20. Yield and spawning stock biomass per recruit estimates and input data for Gulf of Maine cod.

The NEFC Yield and Stock Size per Recruit Program - PDBYPRC
PC Ver.1.2 [Method of Thompson and Bell (1934)] 1-Jan-1992

Run Date: 17- 4-1997; Time: 15:07:56.86
GULF OF MAINE COD (5Y) - 1997 UPDATED AVE WTS, FPAT AND MAT VECTORS

Proportion of F before spawning: .1667
Proportion of M before spawning: .1667
Natural Mortality is Constant at: .200
Initial age is: 1; Last age is: 10
Last age is a PLUS group;
Original age-specific PRs, Mats, and Mean Wts from file:
==> YRCODGMA.DAT

Age-specific Input data for Yield per Recruit Analysis

Age	Fish Mort	Nat Mort	Proportion	Average Weights	
	Pattern	Pattern	Mature	Catch	Stock
1	.0000	1.0000	.0900	.500	.741
2	.0281	1.0000	.2400	1.312	1.081
3	.2110	1.0000	.5400	1.799	1.513
4	.7680	1.0000	.8100	2.716	2.202
5	1.0000	1.0000	.9400	4.215	3.437
6	1.0000	1.0000	1.0000	6.439	5.330
7	1.0000	1.0000	1.0000	9.064	7.608
8	1.0000	1.0000	1.0000	11.484	10.160
9	1.0000	1.0000	1.0000	13.787	12.479
10+	1.0000	1.0000	1.0000	17.771	17.771

Summary of Yield per Recruit Analysis for:
GULF OF MAINE COD (5Y) - 1997 UPDATED AVE WTS, FPAT AND MAT VECTORS

Slope of the Yield/Recruit Curve at F=0.00: --> 27.4085
F Level at slope=1/10 of the above slope (F0.1): -----> .163
Yield/Recruit corresponding to F0.1: -----> 1.7404
F level to produce Maximum Yield/Recruit (Fmax): -----> .289
Yield/Recruit corresponding to Fmax: -----> 1.8713
F level at 20 % of Max Spawning Potential (F20): -----> .373
SSB/Recruit corresponding to F20: -----> 5.5590

Listing of Yield per Recruit Results for:
GULF OF MAINE COD (5Y) - 1997 UPDATED AVE WTS, FPAT AND MAT VECTORS

FMORT	TOTCTHN	TOTCTHW	TOTSTKN	TOTSTKW	SPNSTKN	SPNSTKW	% MSP
.00	.00000	.00000	5.5167	30.8756	3.4286	27.7974	100.00
.10	.18611	1.45976	4.5906	17.9353	2.5073	15.0585	54.17
F0.1	.25119	1.74042	4.2678	13.9846	2.1874	11.2009	40.29
.20	.28051	1.81725	4.1228	12.3471	2.0439	9.6100	34.57
Fmax	.33293	1.87129	3.8642	9.6907	1.7891	7.0440	25.34
.30	.33816	1.87072	3.8384	9.4471	1.7638	6.8099	24.50
F20%	.36799	1.84735	3.6920	8.1405	1.6203	5.5590	20.00
.40	.37739	1.83317	3.6460	7.7596	1.5753	5.1961	18.69
.50	.40605	1.77175	3.5061	6.6935	1.4392	4.1860	15.06
.60	.42809	1.70884	3.3992	5.9758	1.3359	3.5123	12.64
.70	.44568	1.65149	3.3144	5.4673	1.2545	3.0392	10.93
.80	.46013	1.60133	3.2450	5.0916	1.1884	2.6927	9.69
.90	.47229	1.55810	3.1870	4.8040	1.1334	2.4297	8.74
1.00	.48271	1.52096	3.1374	4.5773	1.0869	2.2242	8.00
1.10	.49179	1.48898	3.0945	4.3941	1.0469	2.0595	7.41
1.20	.49979	1.46130	3.0569	4.2428	1.0120	1.9247	6.92
1.30	.50694	1.43721	3.0234	4.1157	.9811	1.8123	6.52
1.40	.51337	1.41609	2.9933	4.0072	.9537	1.7170	6.18
1.50	.51920	1.39747	2.9662	3.9133	.9290	1.6352	5.88
1.60	.52454	1.38094	2.9414	3.8311	.9066	1.5642	5.63
1.70	.52966	1.36618	2.9187	3.7584	.8863	1.5017	5.40
1.80	.53400	1.35292	2.8977	3.6934	.8676	1.4464	5.20
1.90	.53823	1.34094	2.8782	3.6350	.8503	1.3969	5.03
2.00	.54217	1.33006	2.8600	3.5820	.8344	1.3524	4.87

Table 21. Stochastic stock biomass and catch projections, starting conditions and input data for Gulf of Maine cod.

Input for Projections:

Number of Years: 4; Initial Year: 1994; Final Year: 1997

Number of Ages : 6; Age at Recruitment: 2; Last Age: 7

Natural Mortality is assumed Constant over time at: .200

Proportion of F before spawning: .1667

Proportion of M before spawning: .1667

Last age is a PLUS group;

Age-specific Input data for Projection # 1

Age	Stock Size in 1997	Fish Mort Pattern	Nat Mort Pattern	Proportion Mature	Average Weights Catch Stock
2	721.	.0281	1.0000	.2400	1.523 1.169
3	730.	.2111	1.0000	.5400	1.962 1.662
4	1370.	.7680	1.0000	.8100	2.706 2.232
5	1224.	1.0000	1.0000	.9400	3.930 3.272
6	125.	1.0000	1.0000	1.0000	6.594 5.113
7+	27.	1.0000	1.0000	1.0000	11.262 11.262

Projections for 1997-1999; $F(97)=1.04$, Basis: Status quo 1996 point estimate.
 Recruitment (age 2) of the 1996 and 1997 year classes derived by resampling
 the distribution of empirical recruitment of the 1988-1994 year classes
 (median=3.1 million).

SSB was estimated to be 9,300 t in 1996.

1997			1998			1999		
F	Landings	SSB	F	Landings	SSB	F	Landings	SSB
1.04	5838	6861	$F_0 = 0.00$	0	5335	9456		
1.04	5838	6861	$F_{0.1} = 0.16$	842	5411	8264		
1.04	5838	6861	$F_{max} = 0.29$	1437	5313	7419		
1.04	5838	6861	$F_{20\%} = 0.37$	1789	5250	6926		
1.04	5838	6861	$F_{sq} = 1.04$	3857	4781	4296		

GULF OF MAINE COD
TOTAL COMMERCIAL LANDINGS
1893 - 1996

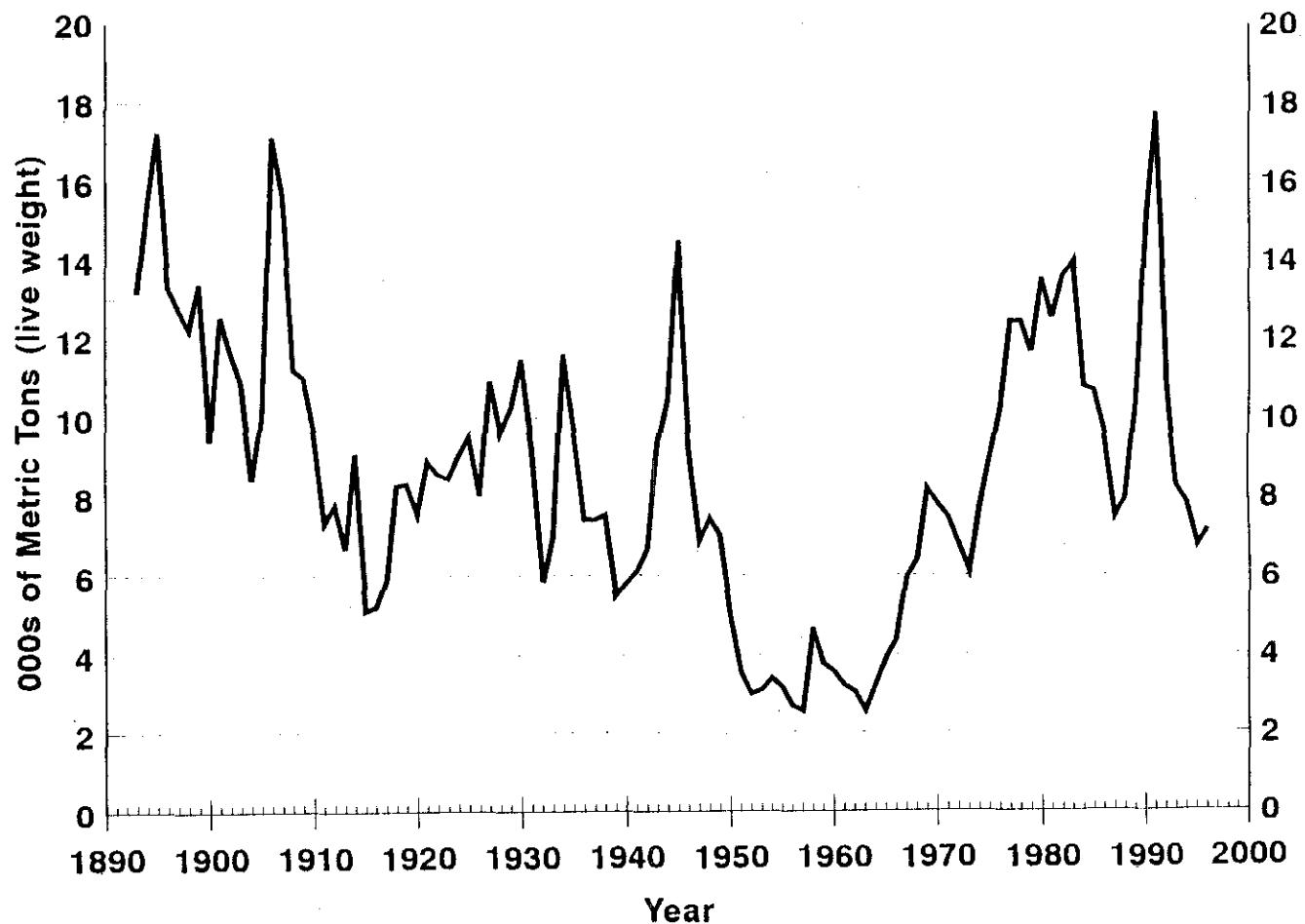


Figure 1. Total commercial landings of Gulf of Maine cod (Division 5Y), 1893-1996.

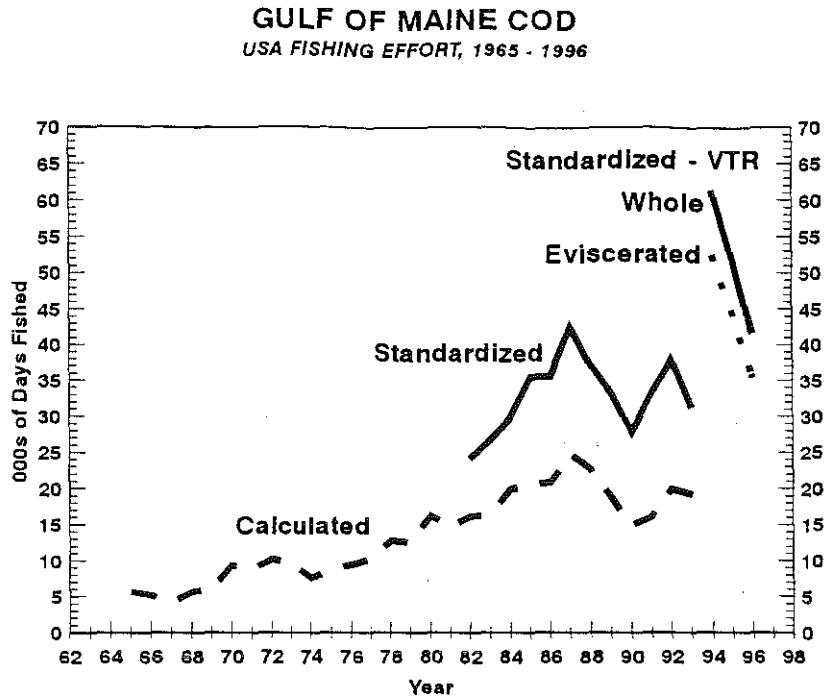


Figure 2. Trends in standardized and 'calculated' USA fishing effort (days fished) on Gulf of Maine cod, 1982-1993 and 1994-1996. Results are based on all otter trawl trips landing cod. Standardized effort series based on a GLM incorporating year, tonnage class, area, quarter and depth. Results from 1994-1996 from VTR data assuming portion kept represents whole or eviscerated weight.

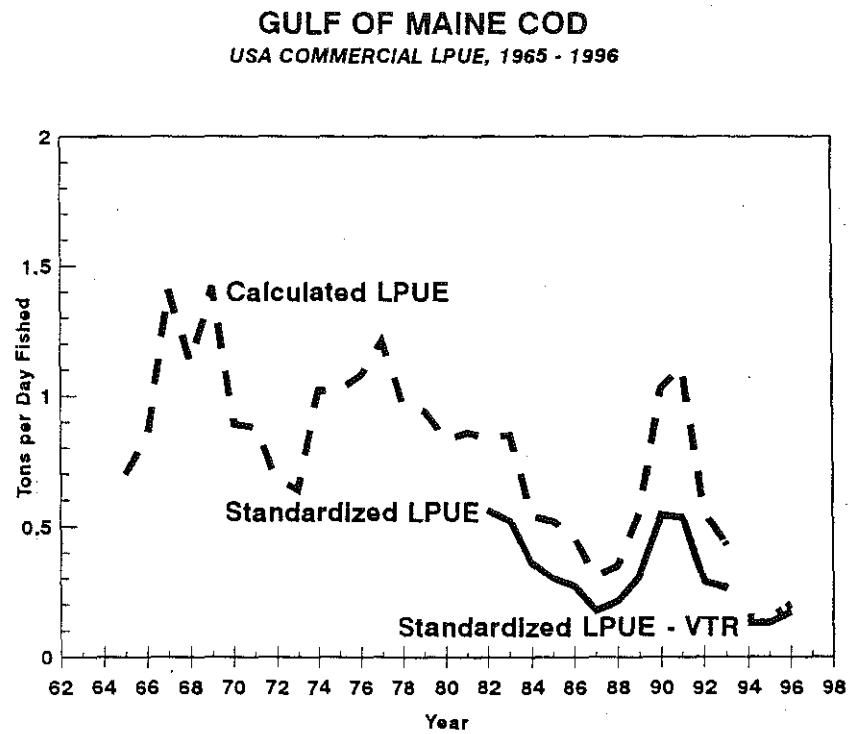


Figure 3. Trends in USA LPUE (landings per day fished) of Gulf of Maine cod. The 1965-1993 indices (dashed line) are based on all otter trawl trips landing cod. Standardized LPUE from 1982-1993 (Interview data) and 1994-1996 (VTR data) are based on a GLM incorporating year, tonnage class, area, quarter and depth.

GULF OF MAINE COD
USA RESEARCH VESSEL BOTTOM-TRAWL SURVEYS
STRATIFIED MEAN CATCH [KG] PER TOW

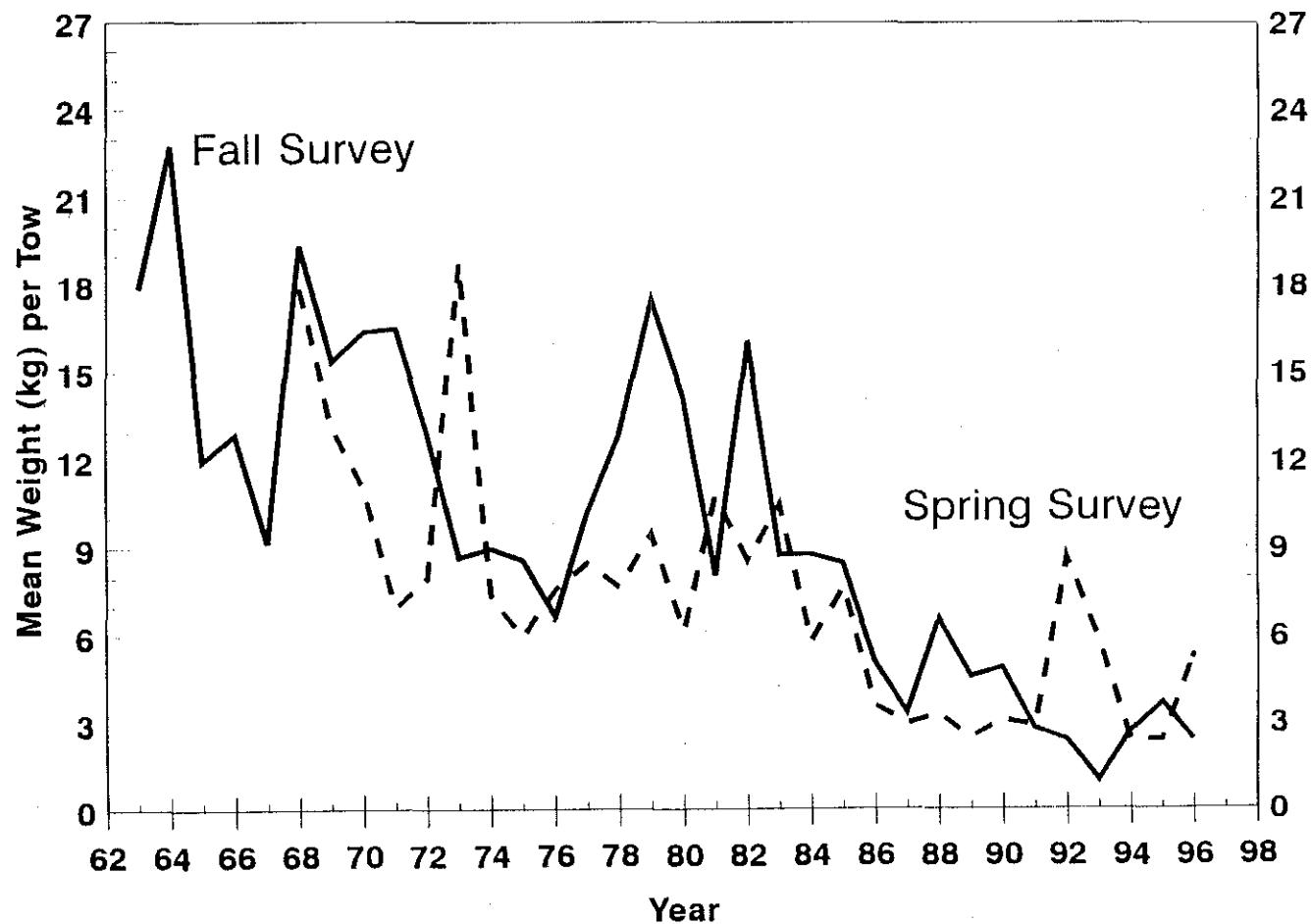


Figure 4. Standardized stratified mean catch (kg) per tow of Atlantic cod in NEFSC spring and autumn research vessel bottom trawl surveys in the Gulf of Maine, 1963-1996.

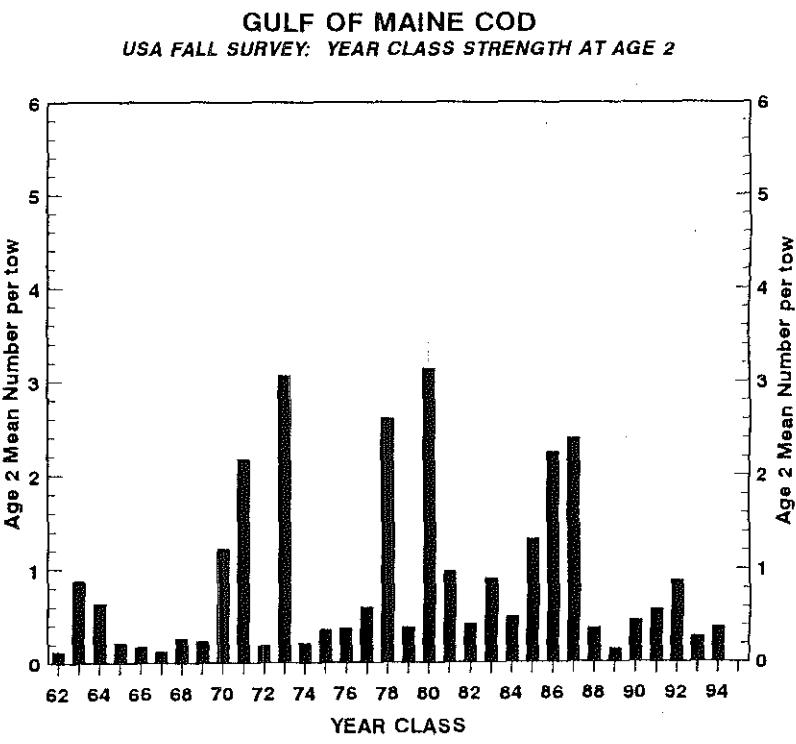
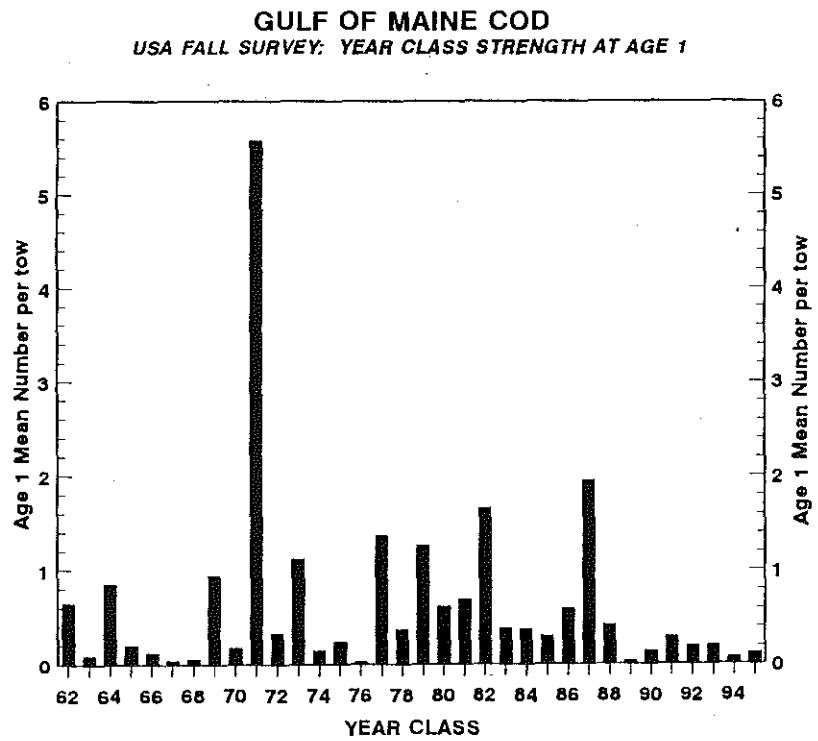


Figure 5. Relative year class strengths of Gulf of Maine cod at age 1 and age 2 based on standardized catch (number) per tow indices from NEFSC autumn research vessel bottom trawl surveys, 1963-1996.

Trends in Landings and Fishing Mortality

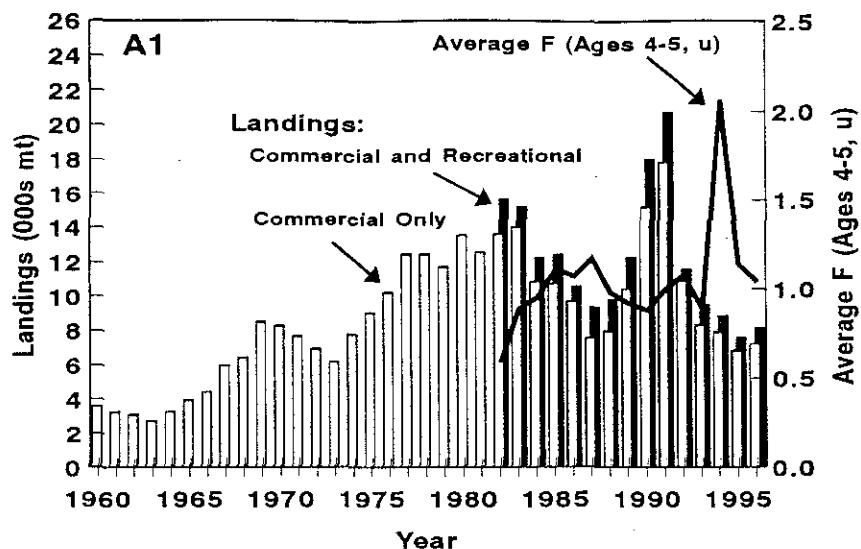


Figure 6. Trends in total commercial landings and fishing mortality for Gulf of Maine cod, 1982-1996.

Trends in Spawning Stock Biomass and Recruitment

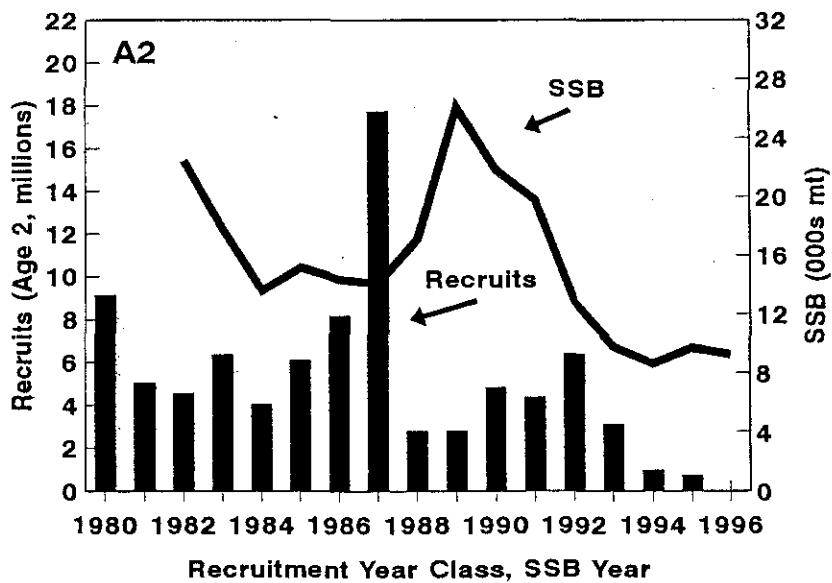


Figure 7. Trends in spawning stock biomass and recruitment for Gulf of Maine cod.

**Gulf of Maine Cod
Precision of 1996 F Estimate**

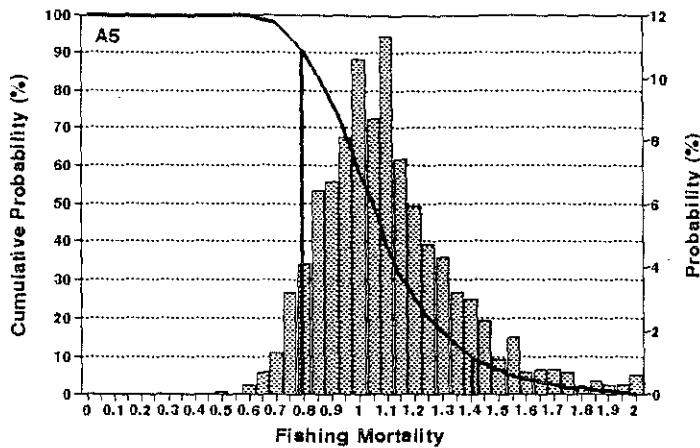


Figure 8. Precision of the estimates of the instantaneous rate of fishing mortality (F) on the fully recruited ages (ages 4+) in 1996 for Gulf of Maine cod. The vertical bars display both the range of the estimator and the probability of individual values within the range. The solid line gives the probability that F is greater than any selected value on the X-axis. The precision estimates were derived from 1000 bootstrap replicates of the final ADAPT VPA formulation.

**Gulf of Maine Cod
Precision of 1996 SSB Estimate**

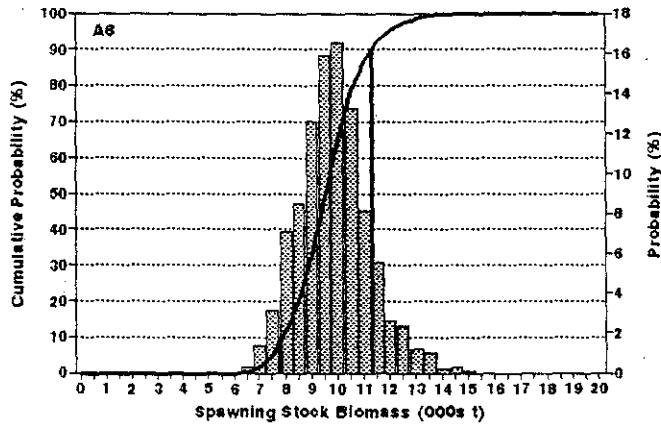


Figure 9. Precision of the estimates of spawning stock biomass (SSB) at the beginning of the spawning season (March 1) for Gulf of Maine cod, 1996. The vertical bars display both the range of the estimator and the probability of individual values within the range. The solid line gives the probability that SSB is less than any selected value on the X-axis. The precision estimates were derived from 1000 bootstrap replicates of the final ADAPT VPA formulation.

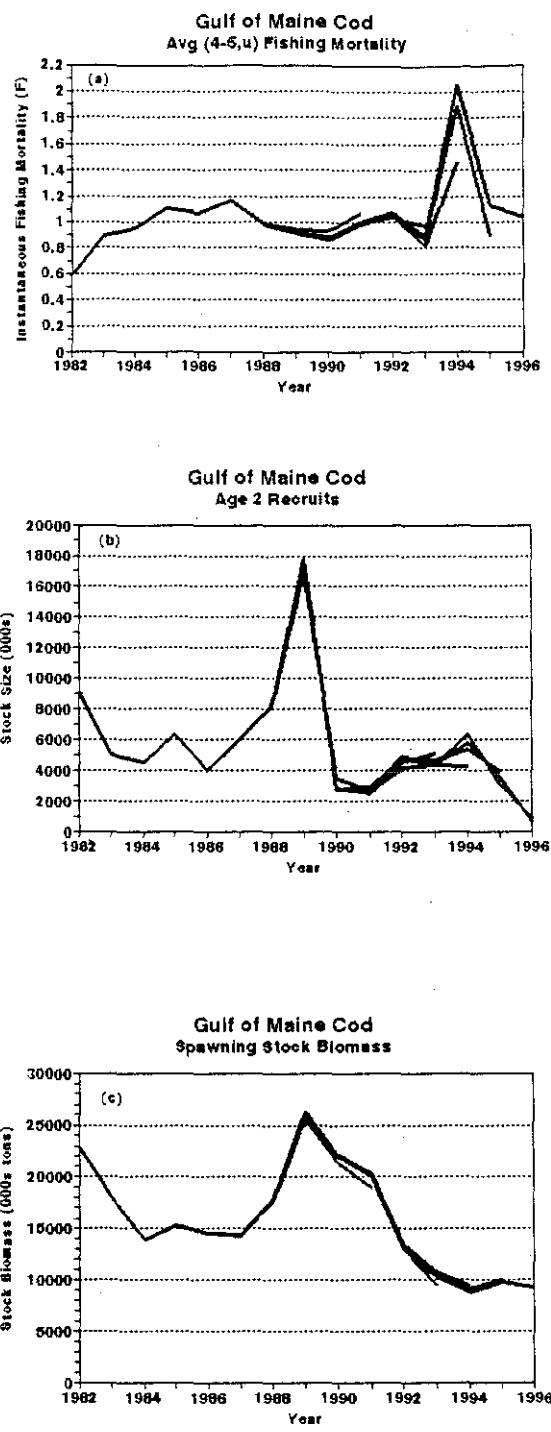


Figure 10. Retrospective analysis of Gulf of Maine cod VPA based on final ADAPT formulation.

- Average (4-5,unweighted) fishing mortality
- Recruits (age 2)
- Spawning stock biomass

Yield and Spawning Stock Biomass per Recruit

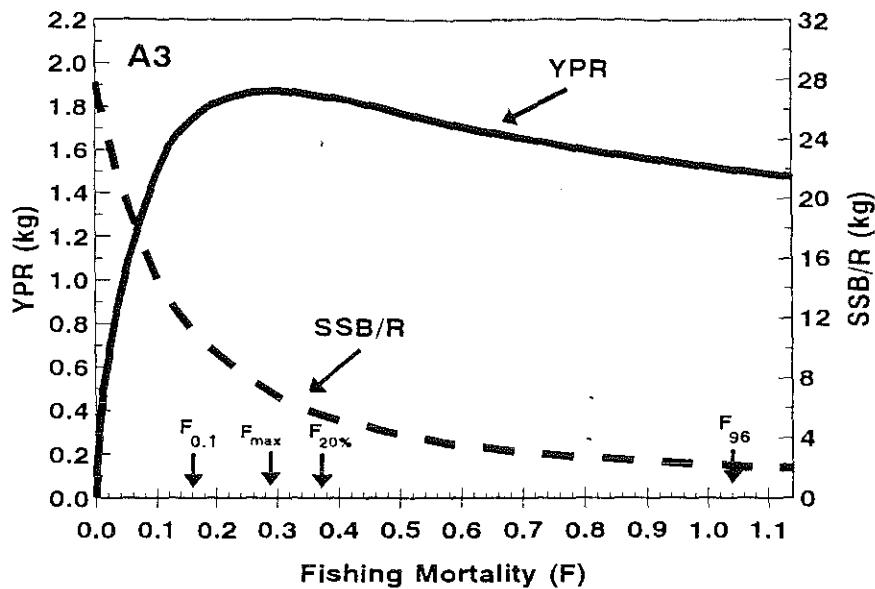


Figure 11. Yield per recruit (YPR) and spawning stock biomass per recruit (SSB/R) for Gulf of Maine cod.

Short-Term Commercial Landings and Spawning Stock Biomass

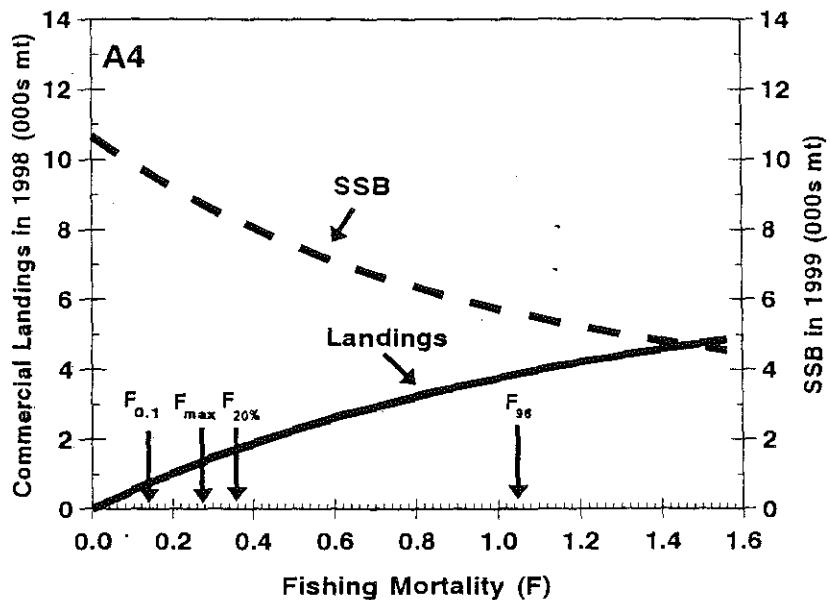


Figure 12. Predicted catches in 1998 and spawning stock biomasses in 1999 of Gulf of Maine cod over a range of fishing mortalities in 1998 from $F=0.0$ to $F=1.6$.

Appendix 1. Discard Estimates for Gulf of Maine cod derived from NEFSC Sea Sampling data, 1989-1996.

Table 1. Gulf of Maine cod discard estimates for otter trawl gear.

Figure 1. Gulf of Maine cod discard estimates for otter trawl gear.

Table 2. Gulf of Maine cod discard estimates for shrimp trawl gear.

Figure 2. Gulf of Maine cod discard estimates for shrimp trawl gear.

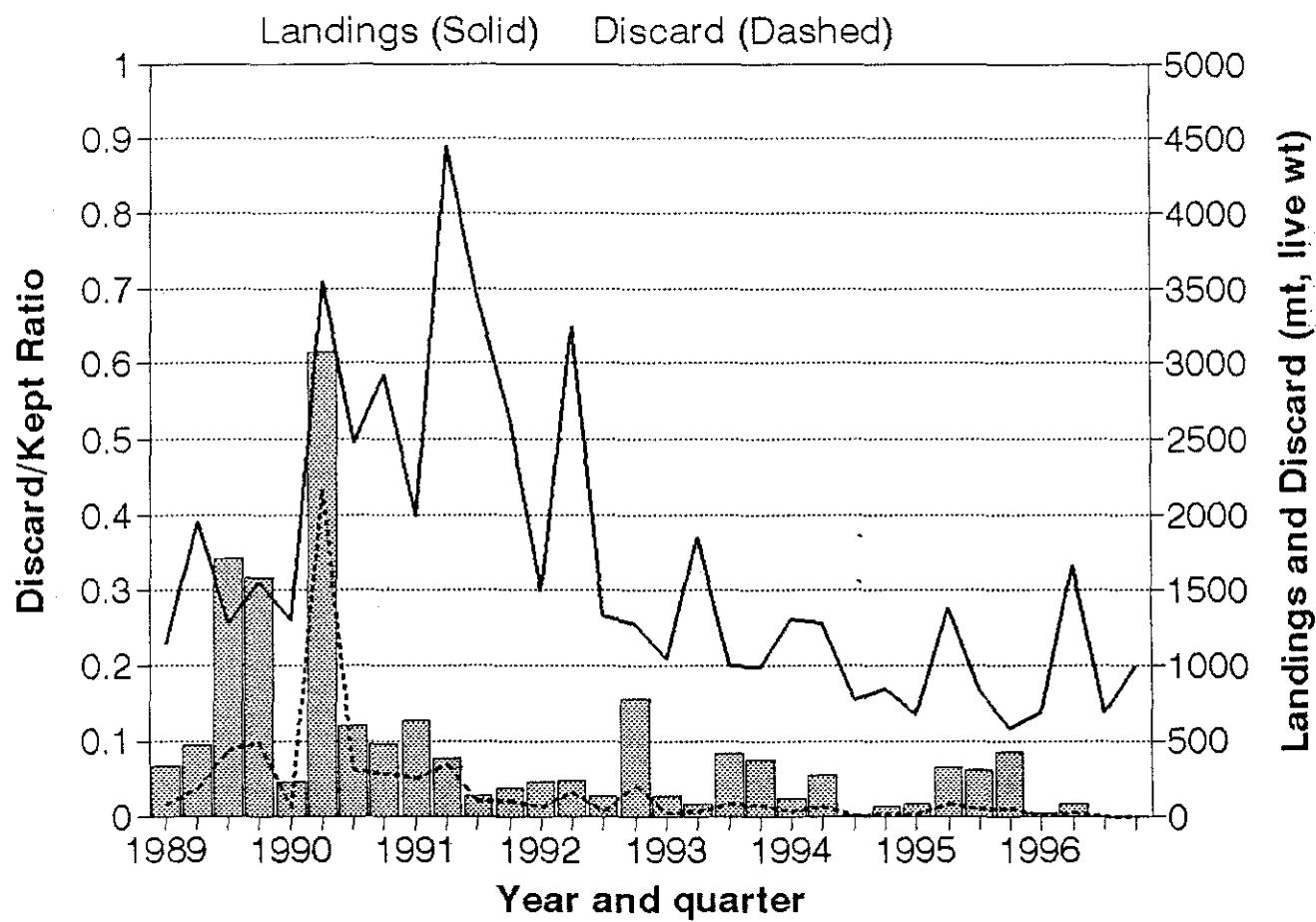
Table 3. Gulf of Maine cod discard estimates for sink gillnet gear.

Figure 3. Gulf of Maine cod discard estimates for sink gillnet gear.

Appendix 1:Table 1. Gulf of Maine cod discard estimates (mt) for otter trawl gear.

Year	Quarter	Num Tow	D/K Ratio	Quarterly Totals Gear=050			Annual Totals Gear=050		
				Landings	Discard	Catch	Landings	Discard	Catch
1989	1	37	0.066	1145	75.6	1220.6			
	2	83	0.093	1956	181.9	2137.9			
	3	82	0.342	1280	437.8	1717.8			
	4	35	0.316	1553	490.7	2043.7	5934.0	1186.0	7120.0
1990	1	3	0.046	1297	59.7	1356.7			
	2	22	0.614	3543	2175.4	5718.4			
	3	39	0.120	2484	298.1	2782.1			
	4	57	0.095	2928	278.2	3206.2	10252.0	2811.3	13063.3
1991	1	33	0.127	1984	252.0	2236.0			
	2	61	0.078	4455	347.5	4802.5			
	3	76	0.028	3448	96.5	3544.5			
	4	395	0.039	2631	102.6	2733.6	12518.0	798.6	13316.6
1992	1	190	0.046	1496	68.8	1564.8			
	2	87	0.049	3248	159.2	3407.2			
	3	83	0.028	1326	37.1	1363.1			
	4	85	0.155	1267	196.4	1463.4	7337.0	461.5	7798.5
1993	1	52	0.027	1046	28.2	1074.2			
	2	33	0.018	1858	33.4	1891.4			
	3	79	0.083	1000	83.0	1083.0			
	4	43	0.075	987	74.0	1061.0	4891.0	218.7	5109.7
1994	1	29	0.024	1312	31.5	1343.5			
	2	5	0.055	1283	70.6	1353.6			
	3	22	0.002	763	1.5	764.5			
	4	27	0.014	848	11.9	859.9	4206.0	115.5	4321.5
1995	1	137	0.017	675	11.5	686.5			
	2	62	0.064	1376	88.1	1464.1			
	3	64	0.060	824	49.4	873.4			
	4	100	0.085	575	48.9	623.9	3450.0	197.9	3647.9
1996	1	46	0.005	678	3.4	681.4			
	2	70	0.018	1669	30.0	1699.0			
	3	11	0.000	678	0.0	678.0			
	4	1	0.000	987	0.0	987.0	4012.0	33.4	4045.4

Gulf of Maine Cod Gear: Otter Trawl

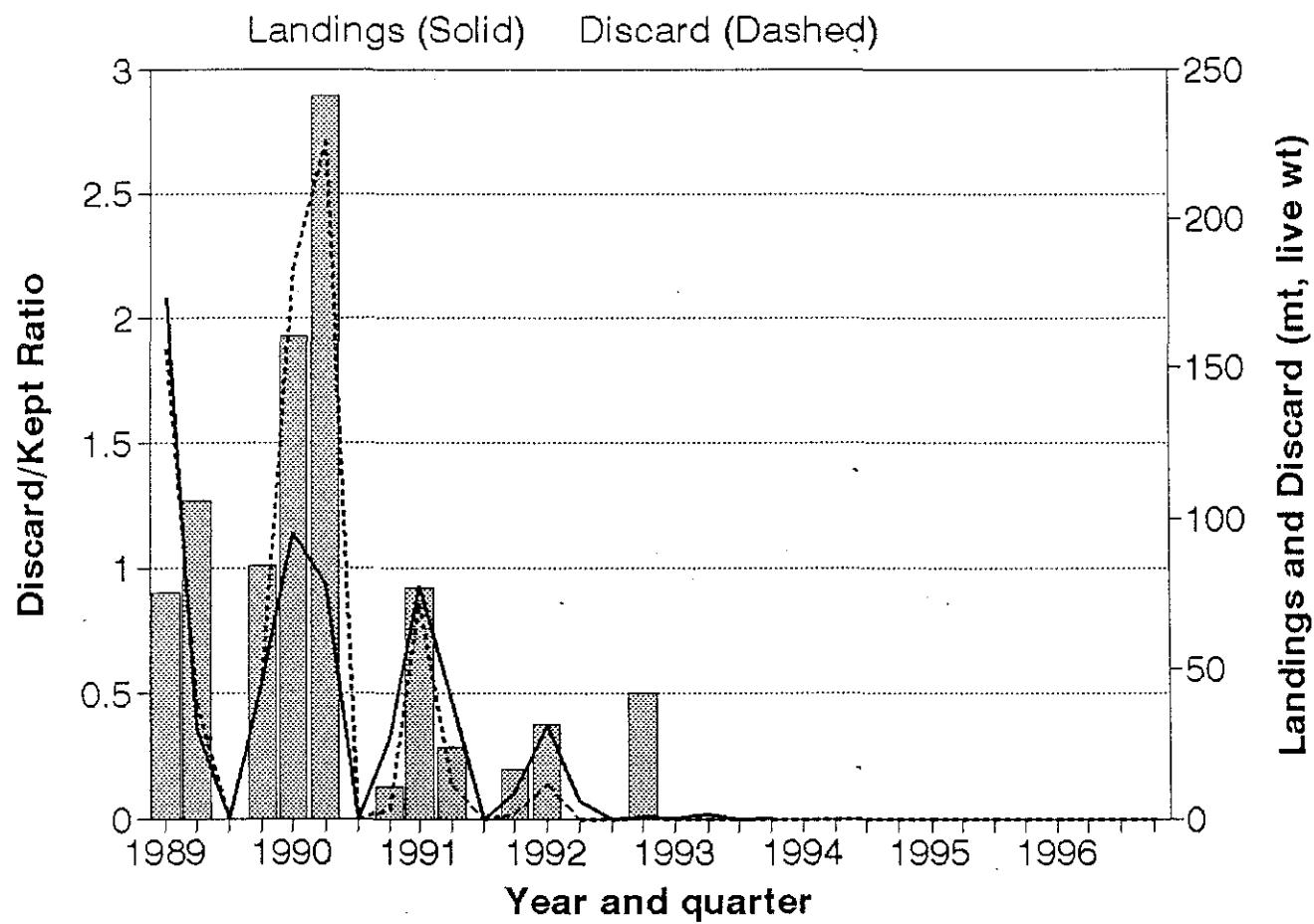


Appendix 1:Figure 1. Gulf of Maine cod discard estimates (dashed line) and D/K ratios (bar) for otter trawl gear.

Appendix 1:Table 2. Gulf of Maine cod discard estimates (mt) for shrimp trawl gear.

Year	Quarter	Num Tow	D/K Ratio	Quarterly Totals Gear=058			Annual Totals Gear=058		
				Landings	Discard	Catch	Landings	Discard	Catch
1989	1	34	0.901	173.4	156.2	329.6			
	2	37	1.272	30.0	38.2	68.2			
	3	0		0.0	0.0	0.0			
	4	77	1.008	45.3	45.7	91.0	248.7	240.1	488.8
1990	1	48	1.922	95.2	183.0	278.2			
	2	17	2.892	78.2	226.2	304.4			
	3	0		0.0	0.0	0.0			
	4	12	0.124	27.0	3.3	30.3	200.4	412.5	612.9
1991	1	68	0.924	77.6	71.7	149.3			
	2	36	0.284	39.1	11.1	50.2			
	3	0		0.0	0.0	0.0			
	4	13	0.203	8.6	1.7	10.3	125.3	84.6	209.9
1992	1	168	0.377	31.3	11.8	43.1			
	2	3	0.000	5.8	0.0	5.8			
	3	0		0.0	0.0	0.0			
	4	7	0.500	0.6	0.3	0.9	37.7	12.1	49.8
1993	1	139	0.000	0.5	0.0	0.5			
	2	2	0.000	1.7	0.0	1.7			
	3	0		0.0	0.0	0.0			
	4	2	0.000	0.2	0.0	0.2	2.4	0.0	2.4
1994	1				0.0	0.0			
	2				0.0	0.0			
	3				0.0	0.0			
	4				0.0	0.0	0.0	0.0	0.0
1995	1				0.0	0.0			
	2				0.0	0.0			
	3				0.0	0.0			
	4				0.0	0.0	0.0	0.0	0.0
1996	1				0.0	0.0			
	2				0.0	0.0			
	3				0.0	0.0			
	4				0.0	0.0	0.0	0.0	0.0

Gulf of Maine Cod Gear: Shrimp Trawl

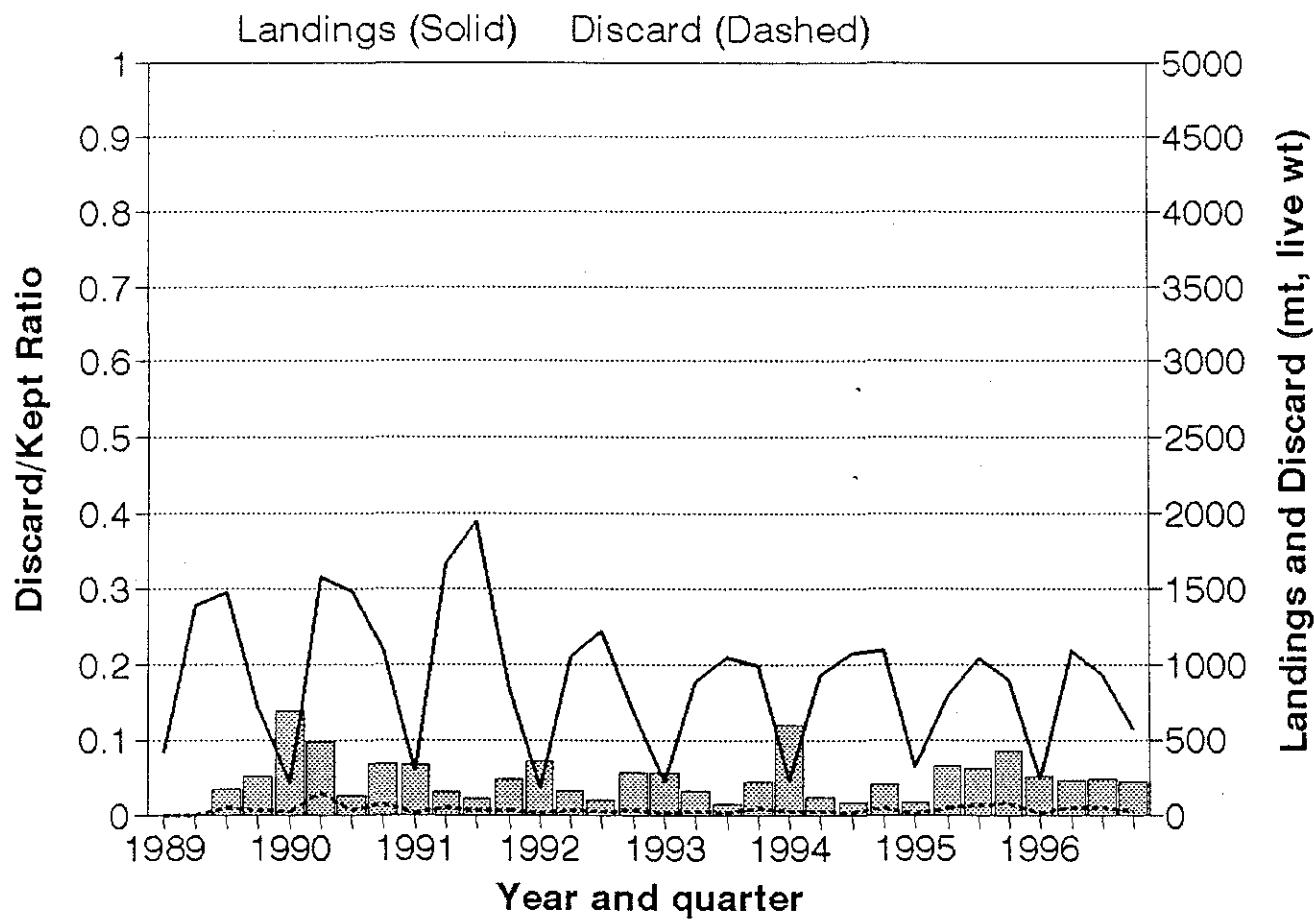


Appendix 1:Figure 2. Gulf of Maine cod discard estimates (dashed line) and D/K ratios (bar) for shrimp trawl gear.

Appendix 1:Table 3. Gulf of Maine cod discard estimates (mt) for sink gillnet gear.

Year	Quarter	Num Sets	D/K Ratio	Quarterly Totals Gear=100			Annual Totals Gear=100		
				Landings	Discard	Catch	Landings	Discard	Catch
1989	1	0		415.8	0.0	415.8			
	2	0		1393.1	0.0	1393.1			
	3	104	0.034	1473.3	50.1	1523.4			
	4	133	0.051	717.3	36.6	753.9	3999.5	86.7	4086.2
1990	1	84	0.138	215.0	29.7	244.7			
	2	177	0.097	1572.7	152.6	1725.3			
	3	107	0.026	1481.8	38.5	1520.3			
	4	102	0.069	1105.3	76.3	1181.6	4374.8	297.0	4671.8
1991	1	59	0.067	289.7	19.4	309.1			
	2	534	0.029	1668.4	48.4	1716.8			
	3	1460	0.021	1945.6	40.9	1986.5			
	4	909	0.048	826.8	39.7	866.5	4730.5	148.3	4878.8
1992	1	252	0.070	180.8	12.7	193.5			
	2	1006	0.032	1056.7	33.8	1090.5			
	3	978	0.019	1213.7	23.1	1236.8			
	4	743	0.056	685.1	38.4	723.5	3136.3	107.9	3244.2
1993	1	124	0.056	225.4	12.6	238.0			
	2	781	0.031	889.2	27.6	916.8			
	3	524	0.016	1053.9	16.9	1070.8			
	4	533	0.044	995.7	43.8	1039.5	3164.2	100.9	3265.1
1994	1	93	0.121	227.0	27.5	254.5			
	2	47	0.023	931.0	21.4	952.4			
	3	95	0.018	1069.0	19.2	1088.2			
	4	71	0.041	1089.0	44.6	1133.6	3316.0	112.8	3428.8
1995	1	33	0.017	314.0	5.3	319.3			
	2	59	0.064	794.0	50.8	844.8			
	3	91	0.060	1043.0	62.6	1105.6			
	4	47	0.085	899.0	76.4	975.4	3050.0	195.1	3245.1
1996	1	29	0.050	237.0	11.9	248.9			
	2	67	0.047	1090.0	51.2	1141.2			
	3	51	0.049	926.0	45.4	971.4			
	4	6	0.044	572.0	25.2	597.2	2825.0	133.6	2958.6

Gulf of Maine Cod Gear: Sink Gill Net



Appendix 1:Figure 3. Gulf of Maine cod discard estimates (dashed line) and D/K ratios (bar) for sink gillnet gear.

Appendix 2. Age-specific bottom trawl survey abundance indices for Gulf of Maine cod.

Table 1. Stratified mean catch per tow at age (numbers) of Atlantic cod in NEFC offshore spring and autumn bottom trawl surveys in the Gulf of Maine, 1963 - 1996.

Table 2. Standardized [for both door and gear changes] stratified mean number per tow at age and standardized stratified mean weight (kg) per tow of Atlantic cod in NEFSC offshore spring and autumn research vessel bottom trawl surveys in the Gulf of Maine, 1963-1996.

Table 3. Stratified mean catch per tow in numbers and weight (kg) of Atlantic cod in State of Massachusetts inshore spring and autumn bottom trawl surveys in territorial waters adjacent to the Georges Bank area (Mass. Regions 1-3) and in the Gulf of Maine (Mass. Regions 4-5), 1978 - 1996.

Appendix 2:Table 1. Stratified mean catch per tow at age (numbers) of Atlantic cod in NEFC offshore spring and autumn bottom trawl surveys in the Gulf of Maine, 1963 - 1997. [a,b]

Year	Age Group											Totals					Str. Mean Wgt per tow	
	0	1	2	3	4	5	6	7	8	9	10+	0+	1+	2+	3+	4+	5+	
Spring [c]																		
1968	0.082	0.393	0.791	0.902	0.542	0.345	0.133	0.083	0.071	0.038	0.106	3.486	3.404	3.011	2.220	1.318	0.776	11.06
1969	0.000	0.000	0.023	0.197	0.564	0.517	0.406	0.164	0.092	0.057	0.065	2.085	2.085	2.085	2.062	1.865	1.301	8.15
1970	0.000	0.102	0.079	0.035	0.060	0.175	0.299	0.394	0.048	0.038	0.184	1.414	1.414	1.312	1.233	1.198	1.138	6.83
1971	0.000	0.016	0.091	0.070	0.187	0.031	0.053	0.192	0.132	0.099	0.046	0.917	0.917	0.901	0.810	0.740	0.553	4.31
1972	0.000	0.226	0.098	0.333	0.126	0.128	0.023	0.068	0.065	0.147	0.105	1.319	1.319	1.093	0.995	0.662	0.536	4.96
1973	0.000	0.022	2.724	0.581	0.397	0.224	0.125	0.061	0.143	0.161	0.392	4.830	4.830	4.808	2.084	1.503	1.106	11.60
1974	0.000	0.305	0.036	0.871	0.211	0.142	0.073	0.031	0.031	0.013	0.149	1.862	1.862	1.557	1.521	0.650	0.439	4.59
1975	0.004	0.060	0.448	0.068	0.683	0.166	0.071	0.003	0.003	0.012	0.092	1.610	1.606	1.546	1.098	1.030	0.347	3.72
1976	0.000	0.027	0.195	0.672	0.098	0.575	0.055	0.069	0.042	0.000	0.047	1.780	1.780	1.753	1.558	0.886	0.788	4.66
1977	0.000	0.016	0.191	0.334	1.278	0.070	0.507	0.004	0.065	0.000	0.024	2.489	2.489	2.473	2.282	1.948	0.670	5.27
1978	0.000	0.022	0.067	0.183	0.223	0.491	0.048	0.205	0.005	0.068	0.005	1.317	1.317	1.295	1.228	1.045	0.822	4.75
1979	0.028	0.343	1.045	0.136	0.320	0.257	0.439	0.038	0.091	0.008	0.034	2.739	2.711	2.368	1.323	1.187	0.867	5.86
1980	0.057	0.057	0.357	0.278	0.100	0.339	0.194	0.246	0.000	0.105	0.011	1.744	1.687	1.630	1.273	0.995	0.895	5.69
1981	0.000	0.823	0.537	0.800	0.987	0.266	0.233	0.089	0.126	0.086	0.000	3.947	3.947	3.124	2.587	1.787	0.800	9.94
1982	0.012	0.273	0.827	0.419	0.563	0.701	0.095	0.088	0.000	0.034	0.032	3.044	3.032	2.759	1.932	1.513	0.950	7.94
1983	0.008	0.401	0.627	0.534	0.411	0.229	0.116	0.059	0.000	0.058	0.065	2.508	2.500	2.099	1.472	0.938	0.527	6.48
1984	0.000	0.097	0.662	0.735	0.475	0.122	0.034	0.037	0.019	0.000	0.000	2.181	2.181	2.084	1.422	0.687	0.212	3.60
1985	0.000	0.028	0.238	0.622	0.665	0.677	0.095	0.114	0.052	0.000	0.026	2.517	2.517	2.489	2.251	1.629	0.964	7.65
1986	0.000	0.417	0.330	0.647	0.387	0.074	0.046	0.027	0.011	0.000	0.018	1.957	1.957	1.540	1.210	0.563	0.176	3.60
1987	0.000	0.049	0.638	0.486	0.300	0.128	0.011	0.045	0.011	0.000	0.014	1.682	1.682	1.633	0.995	0.509	0.209	3.01
1988	0.029	0.663	1.053	0.633	0.355	0.217	0.087	0.063	0.000	0.027	0.000	3.127	3.098	2.435	1.382	0.749	0.394	3.30
1989	0.000	0.029	0.822	1.000	0.800	0.114	0.097	0.000	0.000	0.000	0.000	2.862	2.862	2.833	2.011	1.011	0.211	3.78
1990	0.000	0.000	0.241	1.680	0.794	0.211	0.041	0.023	0.000	0.000	0.000	2.990	2.990	2.990	2.749	1.069	0.275	4.59
1991	0.000	0.054	0.265	0.449	1.870	0.339	0.030	0.023	0.000	0.000	0.000	3.030	3.030	2.976	2.711	2.262	0.392	4.31
1992	0.000	0.050	0.230	0.240	0.280	1.310	0.220	0.070	0.000	0.010	0.000	2.410	2.410	2.350	2.130	1.890	1.610	8.66
1993	0.000	0.200	0.500	0.800	0.330	0.090	0.480	0.060	0.020	0.000	0.023	2.503	2.503	2.303	1.803	1.003	0.673	5.87
1994	0.000	0.020	0.400	0.490	0.270	0.120	0.060	0.160	0.030	0.030	0.020	1.609	1.609	1.589	1.189	0.699	0.429	3.62
1995	0.000	0.050	0.180	1.120	0.370	0.150	0.030	0.000	0.010	0.000	0.000	1.930	1.930	1.880	1.700	0.580	0.210	2.43
1996	0.000	0.060	0.020	0.590	1.330	0.040	0.060	0.000	0.000	0.000	0.000	2.465	2.465	2.405	2.385	1.795	0.465	5.43
1997	0.000	0.158	0.132	0.399	0.264	0.876	0.242	0.120	0.000	0.000	0.000	2.191	2.191	2.033	1.901	1.502	1.238	5.62

[a] Strata 26-30 and 36-40.

[b] Autumn catch per tow at age values for 1963-1969 obtained by applying combined 1970-1981 age-length keys to stratified mean catch per tow at length distributions from each survey.

[c] Spring surveys during 1973-1981 were accomplished with a '41 Yankee' trawl; in all other years, spring surveys were accomplished with a '36 Yankee' trawl. No adjustments have been made to the catch per tow data for these gear differences.

Appendix 2:Table 1 (Continued). [a,b]

Year	Age Group											Totals					Str. Mean Wgt per tow	
	0	1	2	3	4	5	6	7	8	9	10+	0+	1+	2+	3+	4+	5+	
Autumn																		
1963	0.032	0.416	0.865	0.803	0.544	0.371	0.344	0.192	0.117	0.061	0.048	3.793	3.761	3.345	2.480	1.677	1.133	11.08
1964	0.000	0.059	0.078	0.302	0.549	0.547	0.502	0.239	0.152	0.073	0.065	2.566	2.566	2.507	2.429	2.127	1.578	14.07
1965	0.001	0.545	0.564	0.528	0.481	0.318	0.240	0.109	0.051	0.028	0.016	2.881	2.880	2.335	1.771	1.243	0.762	7.41
1966	0.109	0.131	0.410	0.447	0.460	0.358	0.283	0.123	0.050	0.031	0.023	2.425	2.316	2.185	1.775	1.328	0.868	7.97
1967	0.008	0.083	0.138	0.368	0.430	0.246	0.172	0.104	0.045	0.026	0.022	1.642	1.634	1.551	1.413	1.045	0.615	5.70
1968	0.008	0.023	0.115	0.461	0.805	0.624	0.402	0.167	0.100	0.046	0.061	2.812	2.804	2.781	2.666	2.205	1.400	12.00
1969	0.010	0.038	0.079	0.227	0.404	0.354	0.299	0.141	0.093	0.083	0.040	1.768	1.758	1.720	1.641	1.414	1.010	9.49
1970	0.476	0.603	0.170	0.353	0.211	0.313	0.271	0.506	0.084	0.060	0.094	3.141	2.665	2.062	1.892	1.539	1.328	10.14
1971	0.863	0.114	0.153	0.135	0.383	0.295	0.278	0.163	0.204	0.128	0.082	2.798	1.935	1.821	1.668	1.533	1.150	10.20
1972	0.020	3.576	0.780	0.978	0.150	0.060	0.110	0.025	0.102	0.155	0.010	5.966	5.946	2.370	1.590	0.612	0.462	8.00
1973	0.408	0.210	1.393	0.089	0.325	0.136	0.050	0.018	0.033	0.108	0.087	2.857	2.449	2.239	0.846	0.757	0.432	5.39
1974	0.181	0.720	0.121	1.118	0.187	0.230	0.050	0.008	0.008	0.027	0.127	2.777	2.596	1.876	1.755	0.637	0.450	5.54
1975	0.030	0.094	1.966	0.086	1.510	0.163	0.070	0.011	0.002	0.002	0.008	3.942	3.912	3.818	1.852	1.766	0.256	5.32
1976	0.000	0.156	0.134	0.405	0.064	0.492	0.037	0.061	0.000	0.010	0.020	1.379	1.379	1.223	1.089	0.684	0.620	4.16
1977	0.000	0.018	0.291	0.446	0.937	0.123	0.481	0.031	0.079	0.018	0.078	2.502	2.502	2.484	2.193	1.747	0.810	9.42
1978	0.202	1.111	0.301	0.907	0.532	1.160	0.091	0.264	0.007	0.049	0.041	4.665	4.463	3.352	3.051	2.144	1.612	11.88
1979	0.003	0.236	0.381	0.104	0.536	0.251	0.501	0.033	0.138	0.000	0.053	2.236	2.233	1.997	1.616	1.512	0.976	10.83
1980	0.022	1.026	2.111	1.423	0.403	0.188	0.272	0.168	0.024	0.015	0.058	5.710	5.688	4.662	2.551	1.128	0.725	13.09
1981	0.008	0.397	0.245	0.352	0.304	0.057	0.076	0.024	0.069	0.000	0.018	1.550	1.542	1.145	0.900	0.548	0.244	4.97
1982	0.000	0.449	2.014	1.585	0.748	0.159	0.000	0.025	0.000	0.000	0.000	4.980	4.980	4.531	2.517	0.932	0.184	9.92
1983	0.029	1.064	0.626	0.546	0.089	0.169	0.126	0.000	0.000	0.000	0.058	2.707	2.678	1.614	0.988	0.442	0.353	5.44
1984	0.028	0.246	0.270	0.362	0.256	0.141	0.131	0.057	0.000	0.020	0.042	1.553	1.525	1.279	1.009	0.647	0.391	5.44
1985	0.266	0.378	0.910	0.763	0.209	0.218	0.074	0.000	0.034	0.021	0.049	2.922	2.656	2.278	1.368	0.605	0.396	8.49
1986	0.000	0.301	0.490	0.654	0.333	0.086	0.042	0.000	0.000	0.024	0.021	1.951	1.951	1.650	1.160	0.506	0.173	5.10
1987	0.138	0.599	1.324	0.600	0.257	0.061	0.000	0.000	0.000	0.000	0.000	2.979	2.841	2.242	0.918	0.318	0.061	3.41
1988	0.000	1.951	2.245	0.960	0.528	0.110	0.076	0.033	0.000	0.000	0.000	5.903	5.903	3.952	1.707	0.747	0.219	6.61
1989	0.000	0.526	3.026	1.717	0.372	0.220	0.018	0.000	0.000	0.011	0.000	5.890	5.890	5.364	2.338	0.621	0.249	6.84
1990	0.008	0.037	0.464	2.080	0.788	0.352	0.036	0.013	0.000	0.000	0.000	3.778	3.770	3.733	3.269	1.189	0.401	7.33
1991	0.010	0.180	0.180	0.280	0.800	0.100	0.000	0.030	0.000	0.000	0.000	1.580	1.570	1.390	1.210	0.930	0.130	4.15
1992	0.060	0.290	0.450	0.140	0.040	0.330	0.110	0.000	0.010	0.000	0.000	1.430	1.370	1.080	0.630	0.490	0.450	2.45
1993	0.050	0.250	0.720	0.460	0.040	0.000	0.040	0.000	0.000	0.000	0.000	1.560	1.510	1.260	0.540	0.080	0.040	1.50
1994	0.030	0.210	0.880	0.830	0.090	0.050	0.000	0.050	0.000	0.000	0.000	2.140	2.110	1.900	1.020	0.190	0.100	2.74
1995	0.010	0.070	0.280	1.232	0.330	0.080	0.010	0.000	0.000	0.000	0.000	2.010	2.000	1.930	1.650	0.420	0.090	3.67
1996	0.030	0.120	0.380	0.190	0.540	0.060	0.000	0.000	0.000	0.000	0.000	1.320	1.290	1.170	0.790	0.600	0.060	2.35
1997	0.000	0.297	0.086	0.160	0.182	0.149	0.000	0.000	0.000	0.000	0.000	0.872	0.872	0.575	0.490	0.330	0.149	1.87

[a] Strata 26-30 and 36-40.

[b] Autumn catch per tow at age values for 1963-1969 obtained by applying combined 1970-1981 age-length keys to stratified mean catch per tow at length distributions from each survey.

Appendix 2: Table 2. Standardized [for both door and gear changes] stratified mean number per tow at age and standardized stratified mean weight (kg) per tow of Atlantic cod in NEFSC offshore spring and autumn research vessel bottom trawl surveys in the Gulf of Maine, 1963-1997. [a,b]

Year	Age Group											Totals					Standardized Mean Wt (kg)/Tow	
	0	1	2	3	4	5	6	7	8	9	10+	0+	1+	2+	3+	4+		
Spring [c,d,e]																		
1968	0.128	0.613	1.234	1.407	0.846	0.538	0.207	0.129	0.111	0.059	0.165	5.438	5.310	4.697	3.463	2.056	1.211	17.92
1969	0.000	0.000	0.036	0.307	0.880	0.807	0.633	0.256	0.144	0.089	0.101	3.253	3.253	3.253	3.217	2.909	2.030	13.20
1970	0.000	0.159	0.123	0.055	0.094	0.273	0.466	0.615	0.075	0.059	0.287	2.206	2.206	2.047	1.923	1.869	1.775	11.06
1971	0.000	0.025	0.142	0.109	0.292	0.048	0.083	0.300	0.206	0.154	0.072	1.431	1.431	1.406	1.264	1.154	0.863	6.98
1972	0.000	0.353	0.153	0.519	0.197	0.200	0.036	0.106	0.101	0.229	0.164	2.058	2.058	1.705	1.552	1.033	0.836	8.04
1973	0.000	0.034	4.249	0.906	0.619	0.349	0.195	0.095	0.223	0.251	0.612	7.535	7.535	7.500	3.251	2.345	1.725	18.79
1974	0.000	0.476	0.056	1.359	0.329	0.222	0.114	0.048	0.048	0.020	0.232	2.905	2.905	2.429	2.373	1.014	0.685	7.44
1975	0.006	0.094	0.699	0.106	1.065	0.259	0.111	0.005	0.005	0.019	0.144	2.512	2.505	2.412	1.713	1.607	0.541	6.03
1976	0.000	0.042	0.304	1.048	0.153	0.897	0.086	0.108	0.066	0.000	0.073	2.777	2.777	2.735	2.430	1.382	1.229	7.55
1977	0.000	0.025	0.298	0.521	1.994	0.109	0.791	0.006	0.101	0.000	0.037	3.883	3.883	3.858	3.560	3.039	1.045	8.54
1978	0.000	0.034	0.105	0.285	0.348	0.766	0.075	0.320	0.008	0.106	0.008	2.055	2.055	2.020	1.916	1.630	1.282	7.70
1979	0.044	0.535	1.630	0.212	0.499	0.401	0.685	0.059	0.142	0.012	0.053	4.273	4.229	3.694	2.064	1.852	1.353	9.49
1980	0.070	0.070	0.440	0.343	0.123	0.418	0.239	0.303	0.000	0.129	0.014	2.149	2.079	2.009	1.569	1.226	1.103	6.18
1981	0.000	1.014	0.662	0.986	1.216	0.328	0.287	0.110	0.155	0.106	0.000	4.864	4.864	3.850	3.188	2.202	0.986	10.79
1982	0.015	0.336	1.019	0.516	0.694	0.864	0.117	0.108	0.000	0.042	0.039	3.751	3.737	3.400	2.381	1.865	1.171	8.62
1983	0.012	0.626	0.978	0.833	0.641	0.357	0.181	0.092	0.000	0.090	0.101	3.912	3.900	3.274	2.296	1.463	0.822	10.50
1984	0.000	0.151	1.033	1.147	0.741	0.190	0.053	0.058	0.030	0.000	0.000	3.402	3.402	3.251	2.218	1.072	0.331	5.83
1985	0.000	0.028	0.238	0.622	0.665	0.677	0.095	0.114	0.052	0.000	0.026	2.517	2.517	2.489	2.251	1.629	0.964	7.65
1986	0.000	0.417	0.330	0.647	0.387	0.074	0.046	0.027	0.011	0.000	0.018	1.957	1.957	1.540	1.210	0.563	0.176	3.60
1987	0.000	0.049	0.638	0.486	0.300	0.128	0.011	0.045	0.011	0.000	0.014	1.682	1.682	1.633	0.995	0.509	0.209	3.01
1988	0.029	0.663	1.053	0.633	0.355	0.217	0.087	0.063	0.000	0.027	0.000	3.127	3.098	2.435	1.382	0.749	0.394	3.30
1989	0.000	0.023	0.649	0.790	0.632	0.090	0.077	0.000	0.000	0.000	0.000	2.261	2.261	2.238	1.589	0.799	0.167	2.53
1990	0.000	0.000	0.190	1.327	0.627	0.167	0.032	0.018	0.000	0.000	0.000	2.362	2.362	2.362	2.172	0.845	0.217	3.08
1991	0.000	0.043	0.209	0.355	1.477	0.268	0.024	0.018	0.000	0.000	0.000	2.394	2.394	2.351	2.142	1.787	0.310	2.89
1992	0.000	0.050	0.230	0.240	0.280	1.310	0.220	0.070	0.000	0.010	0.000	2.410	2.410	2.360	2.130	1.890	1.610	8.66
1993	0.000	0.200	0.500	0.800	0.330	0.090	0.480	0.060	0.020	0.000	0.023	2.503	2.503	2.303	1.803	1.003	0.673	5.87
1994	0.000	0.016	0.316	0.387	0.213	0.095	0.047	0.126	0.024	0.024	0.018	1.266	1.266	1.251	0.935	0.547	0.334	2.43
1995	0.000	0.050	0.180	1.120	0.370	0.150	0.030	0.000	0.010	0.000	0.000	1.910	1.910	1.860	1.680	0.560	0.190	2.43
1996	0.000	0.060	0.020	0.590	1.330	0.400	0.060	0.000	0.000	0.000	0.000	2.465	2.465	2.405	2.385	1.795	0.465	5.43
1997	0.000	0.158	0.132	0.399	0.264	0.876	0.242	0.120	0.000	0.000	0.000	2.191	2.191	2.033	1.901	1.502	1.238	5.62

[a] Strata 26-30 and 36-40.

[b] Autumn catch per tow at age values for 1963-1969 obtained by applying combined 1970-1981 age-length keys to stratified mean catch per tow at length distributions from each survey.

[c] Spring surveys during 1973-1981 were accomplished with a '41 Yankee' trawl; in all other years, spring surveys were accomplished with a '36 Yankee' trawl. No adjustments have been made to the catch per tow data for these differences.

[d] During 1963-1984, BMV oval doors were used in the spring and autumn surveys; since 1985, Portuguese polyvalent doors have been used in both surveys. Adjustments have been made to the 1963-1984 catch per tow data to standardize these data to polyvalent door equivalents. Conversion coefficients of 1.56 (numbers) and 1.62 (weight) were used in this standardization (NEFSC 1991).

[e] In the Gulf of Maine, spring surveys during 1980-1982, 1989-1991 and 1994, and autumn surveys during 1977-1978, 1980, 1989-1991 and 1993, were accomplished with the R/V DELAWARE II; in all other years, the surveys were accomplished using the R/V ALBATROSS IV. Adjustments have been made to the R/V DELAWARE II catch per tow data to standardize these to R/V ALBATROSS IV equivalents. Conversion coefficients of 0.79 (numbers) and 0.67 (weight) were used in this standardization (NEFSC 1991).

Appendix 2:Table 2 (Continued). [a,b]

Year	Age Group											Totals					Standardized Mean Wt (kg)/Tow	
	0	1	2	3	4	5	6	7	8	9	10+	0+	1+	2+	3+	4+	5+	
Autumn [d,e]																		
1963	0.050	0.649	1.349	1.253	0.849	0.579	0.537	0.300	0.183	0.095	0.075	5.917	5.867	5.218	3.869	2.616	1.767	17.95
1964	0.000	0.092	0.122	0.471	0.856	0.853	0.783	0.373	0.237	0.114	0.101	4.003	4.003	3.911	3.789	3.318	2.462	22.79
1965	0.002	0.850	0.880	0.824	0.750	0.496	0.374	0.170	0.080	0.044	0.025	4.494	4.493	3.643	2.763	1.939	1.189	12.00
1966	0.170	0.204	0.640	0.697	0.718	0.558	0.441	0.192	0.078	0.048	0.036	3.783	3.613	3.409	2.769	2.072	1.354	12.91
1967	0.012	0.129	0.215	0.574	0.671	0.384	0.268	0.162	0.070	0.041	0.034	2.562	2.549	2.420	2.204	1.630	0.959	9.23
1968	0.012	0.036	0.179	0.719	1.256	0.973	0.627	0.261	0.156	0.072	0.095	4.387	4.374	4.338	4.159	3.440	2.184	19.44
1969	0.016	0.059	0.123	0.354	0.630	0.552	0.466	0.220	0.145	0.129	0.062	2.758	2.742	2.683	2.560	2.206	1.576	15.37
1970	0.743	0.941	0.265	0.551	0.329	0.488	0.423	0.789	0.131	0.094	0.147	4.900	4.157	3.217	2.952	2.401	2.072	16.43
1971	1.346	0.178	0.239	0.211	0.597	0.460	0.434	0.254	0.318	0.200	0.128	4.365	3.019	2.841	2.602	2.391	1.794	16.52
1972	0.031	5.579	1.217	1.526	0.234	0.094	0.172	0.039	0.159	0.242	0.016	9.307	9.276	3.697	2.480	0.955	0.721	12.96
1973	0.636	0.328	2.173	0.139	0.507	0.212	0.078	0.028	0.051	0.168	0.136	4.457	3.820	3.493	1.320	1.181	0.674	8.73
1974	0.282	1.123	0.189	1.744	0.292	0.359	0.078	0.012	0.012	0.042	0.198	4.332	4.050	2.927	2.738	0.994	0.702	8.97
1975	0.047	0.147	3.067	0.134	2.356	0.254	0.109	0.017	0.003	0.003	0.012	6.150	6.103	5.956	2.889	2.755	0.399	8.62
1976	0.000	0.243	0.209	0.632	0.100	0.768	0.058	0.095	0.000	0.016	0.031	2.151	2.151	1.908	1.699	1.067	0.967	6.74
1977	0.000	0.022	0.359	0.550	1.155	0.152	0.593	0.038	0.097	0.022	0.096	3.083	3.083	3.061	2.703	2.153	0.998	10.22
1978	0.249	1.369	0.371	1.118	0.656	1.430	0.112	0.325	0.009	0.060	0.051	5.749	5.500	4.131	3.760	2.642	1.987	12.89
1979	0.005	0.368	0.594	0.162	0.836	0.392	0.782	0.051	0.215	0.000	0.083	3.488	3.483	3.115	2.521	2.359	1.523	17.54
1980	0.027	1.264	2.602	1.754	0.497	0.232	0.335	0.207	0.030	0.018	0.071	7.037	7.010	5.745	3.144	1.390	0.893	14.21
1981	0.012	0.619	0.382	0.549	0.474	0.089	0.119	0.037	0.108	0.000	0.028	2.418	2.406	1.786	1.404	0.855	0.381	8.05
1982	0.000	0.700	3.142	2.473	1.167	0.248	0.000	0.039	0.000	0.000	0.000	7.769	7.769	7.068	3.927	1.454	0.287	16.07
1983	0.045	1.660	0.977	0.852	0.139	0.264	0.197	0.000	0.000	0.000	0.090	4.223	4.178	2.518	1.541	0.690	0.551	8.81
1984	0.044	0.384	0.421	0.565	0.399	0.220	0.204	0.089	0.000	0.031	0.066	2.423	2.379	1.995	1.574	1.009	0.610	8.81
1985	0.266	0.378	0.910	0.763	0.209	0.218	0.074	0.000	0.034	0.021	0.049	2.922	2.656	2.278	1.368	0.605	0.396	8.49
1986	0.000	0.301	0.490	0.654	0.333	0.086	0.042	0.000	0.000	0.024	0.021	1.951	1.951	1.650	1.160	0.506	0.173	5.10
1987	0.138	0.599	1.324	0.600	0.257	0.061	0.000	0.000	0.000	0.000	0.000	2.979	2.841	2.242	0.918	0.318	0.061	3.41
1988	0.000	1.951	2.245	0.960	0.528	0.110	0.076	0.033	0.000	0.000	0.000	5.903	5.903	3.952	1.707	0.747	0.219	6.61
1989	0.000	0.416	2.391	1.356	0.294	0.174	0.014	0.000	0.000	0.009	0.000	4.653	4.653	4.238	1.847	0.491	0.197	4.58
1990	0.006	0.029	0.367	1.643	0.623	0.278	0.028	0.010	0.000	0.000	0.000	2.985	2.978	2.949	2.583	0.939	0.317	4.91
1991	0.008	0.142	0.142	0.221	0.632	0.079	0.000	0.024	0.000	0.000	0.000	1.248	1.240	1.098	0.956	0.735	0.103	2.78
1992	0.060	0.290	0.450	0.140	0.040	0.330	0.110	0.000	0.010	0.000	0.000	1.430	1.370	1.080	0.630	0.490	0.450	2.45
1993	0.040	0.198	0.569	0.363	0.032	0.000	0.032	0.000	0.000	0.000	0.000	1.232	1.193	0.995	0.427	0.063	0.032	1.00
1994	0.030	0.210	0.880	0.830	0.090	0.050	0.000	0.050	0.000	0.000	0.000	2.140	2.110	1.900	1.020	0.190	0.100	2.74
1995	0.010	0.070	0.280	1.230	0.330	0.080	0.010	0.000	0.000	0.000	0.000	2.010	2.000	1.930	1.650	0.420	0.090	3.67
1996	0.030	0.120	0.380	0.190	0.540	0.060	0.000	0.000	0.000	0.000	0.000	1.320	1.290	1.170	0.790	0.600	0.060	2.35
1997	0.000	0.297	0.086	0.160	0.182	0.149	0.000	0.000	0.000	0.000	0.000	0.872	0.872	0.575	0.490	0.330	0.149	1.87

[a] Strata 26-30 and 36-40.

[b] Autumn catch per tow at age values for 1963-1969 obtained by applying combined 1970-1981 age-length keys to stratified mean catch per tow at length distributions from each survey.

[d] During 1963-1984, BMV oval doors were used in the spring and autumn surveys; since 1985, Portuguese polyvalent doors have been used in both surveys. Adjustments have been made to the 1963-1984 catch per tow data to standardize these data to polyvalent door equivalents. Conversion coefficients of 1.56 (numbers) and 1.62 (weight) were used in this standardization (NEFSC 1991).

[e] In the Gulf of Maine, spring surveys during 1980-1982, 1989-1991 and 1994, and autumn surveys during 1977-1978, 1980, 1989-1991 and 1993 were accomplished with the R/V DELAWARE II; in all other years, the surveys were accomplished using the R/V ALBATROSS IV. Adjustments have been made to the R/V DELAWARE II catch per tow data to standardize these to R/V ALBATROSS IV equivalents. Conversion coefficients of 0.79 (numbers) and 0.67 (weight) were used in this standardization (NEFSC 1991).

Appendix 2:Table 3. Stratified mean catch per tow in numbers and weight (kg) of Atlantic cod in State of Massachusetts inshore spring and autumn bottom trawl surveys in territorial waters adjacent to the Gulf of Maine (Mass. Regions 4-5), 1978 - 1997. [a]

Year	Age Group											Totals				Stratified Mean Weight (kg)
	0	1	2	3	4	5	6	7	8	9	10+	0+	1+	2+	3+	
Gulf of Maine Area (Mass. Regions 4-5)																
Spring																
1978	21.965	12.784	4.162	4.572	0.872	1.028	0.000	0.000	0.023	0.000	0.000	45.406	23.441	10.657	6.495	12.16
1979	56.393	36.630	2.581	1.533	4.659	1.995	0.183	0.000	0.000	0.069	0.000	104.043	47.650	11.020	8.439	20.53
1980	8.156	50.311	12.679	0.971	0.745	0.737	0.080	0.214	0.000	0.025	0.000	73.918	65.762	15.451	2.772	17.71
1981	19.753	24.794	23.884	3.122	1.279	0.041	0.146	0.022	0.022	0.000	0.000	73.063	53.310	28.516	4.632	21.79
1982	1.489	16.235	7.060	3.418	1.147	0.232	0.011	0.057	0.045	0.000	0.000	29.694	28.205	11.970	4.910	13.42
1983	0.453	27.703	18.572	5.331	0.501	1.221	0.142	0.022	0.000	0.000	0.000	53.945	53.492	25.789	7.217	19.77
1984	0.206	2.896	5.408	2.271	0.865	0.138	0.162	0.000	0.000	0.000	0.000	11.946	11.740	8.844	3.436	8.63
1985	0.793	2.711	3.822	2.794	0.692	0.000	0.000	0.000	0.000	0.000	0.000	10.812	10.019	7.308	3.486	6.42
1986	0.957	19.960	3.222	0.887	0.426	0.090	0.019	0.000	0.000	0.000	0.000	25.561	24.604	4.644	1.422	7.77
1987	0.659	8.590	6.997	2.268	0.257	0.147	0.048	0.000	0.000	0.087	0.000	19.053	18.394	9.804	2.807	9.59
1988	1.595	11.841	11.356	2.511	1.370	0.000	0.039	0.000	0.000	0.000	0.000	28.712	27.117	15.276	3.920	9.66
1989	0.157	20.679	25.260	6.580	0.458	0.106	0.124	0.000	0.000	0.000	0.000	53.364	53.207	32.528	7.268	18.26
1990	4.10	6.33	6.89	17.77	2.64	0.18	0.05	0.02	0.000	0.000	0.000	37.980	33.88	27.55	20.66	19.51
1991	0.32	5.88	3.56	2.54	5.03	0.36	0.000	0.000	0.000	0.000	0.000	17.69	17.37	11.49	7.93	11.37
1992	1.36	6.42	6.35	3.58	0.65	1.37	0.12	0.04	0.00	0.00	0.00	19.88	18.53	12.11	5.76	10.10
1993	69.03	3.40	7.76	3.60	1.45	0.05	0.30	0.00	0.00	0.00	0.00	85.59	16.56	13.16	5.40	7.63
1994	3.90	4.45	5.67	2.46	0.52	0.23	0.03	0.06	0.00	0.03	0.00	17.35	13.45	9.00	3.33	4.83
1995	9.84	6.41	1.36	3.89	1.20	0.09	0.00	0.00	0.00	0.00	0.00	22.79	12.95	6.54	5.18	4.49
1996	6.40	1.29	0.97	2.11	0.81	0.36	0.00	0.00	0.00	0.00	0.00	11.96	5.56	4.27	3.50	4.06
1997	10.40	3.66	1.00	1.34	0.20	0.42	0.00	0.00	0.00	0.00	0.00	17.09	6.69	3.03	2.03	2.97
Autumn																
1978	151.533	2.082	0.000	0.120	0.140	0.318	0.000	0.080	0.000	0.000	0.000	154.273	2.740	0.658	0.658	3.02
1979	4.933	3.430	0.042	0.000	0.026	0.000	0.000	0.000	0.000	0.000	0.000	8.431	3.498	0.068	0.026	0.99
1980	5.680	8.834	0.052	0.000	0.000	0.050	0.000	0.000	0.000	0.000	0.000	14.616	8.936	0.102	0.050	1.57
1981	2.018	5.652	7.290	0.729	0.000	0.000	0.000	0.000	0.000	0.000	0.000	15.689	13.671	8.019	0.729	6.65
1982	4.667	2.346	1.005	0.060	0.050	0.000	0.000	0.000	0.000	0.000	0.000	8.128	3.461	1.115	0.110	1.35
1983	1.308	0.651	0.100	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.072	0.764	0.113	0.013	0.18
1984	12.296	0.344	0.022	0.013	0.000	0.000	0.000	0.000	0.000	0.000	0.000	12.675	0.379	0.035	0.013	0.18
1985	2.832	0.419	0.018	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.279	0.447	0.028	0.010	0.09
1986	2.478	1.150	0.833	0.000	0.067	0.000	0.000	0.000	0.000	0.000	0.000	4.528	2.050	0.900	0.067	0.55
1987	389.584	2.386	0.020	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	391.990	2.406	0.020	0.000	0.45
1988	4.571	20.490	0.679	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	25.740	21.169	0.679	0.000	1.57
1989	2.971	2.700	0.350	0.210	0.185	0.000	0.000	0.000	0.000	0.000	0.000	6.416	3.445	0.745	0.395	1.27
1990	9.37	9.13	1.74	0.31	0.06	0.03	0.000	0.000	0.000	0.000	0.000	20.638	11.27	2.14	0.40	1.56
1991	4.65	4.20	0.81	0.03	0.05	0.01	0.00	0.00	0.00	0.00	0.00	9.74	5.09	0.89	0.08	0.80
1992	24.30	2.01	0.11	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00	26.48	2.18	0.17	0.06	0.42
1993	49.92	3.32	0.61	0.33	0.00	0.00	0.01	0.00	0.00	0.00	0.00	54.21	4.29	0.97	0.36	1.97
1994	33.49	14.13	6.37	0.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	54.26	20.77	6.64	0.27	4.47
1995	2.56	0.64	0.54	0.79	0.02	0.00	0.00	0.00	0.00	0.00	0.00	4.55	1.99	1.35	0.81	0.74
1996	7.59	0.15	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	7.78	0.19	0.04	0.03	0.09
1997	2.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.04	0.02	0.00	0.00	0.02

[a] Massachusetts sampling strata 25-36.

Appendix 3. Full listing of final ADAPT VPA calibration for Gulf of Maine cod including:

Estimates of 1997 N for ages 2-6 using:

NEFSC spring and autumn surveys for ages 2-6,

Massachusetts DMF spring surveys for ages 2-4 and autumn surveys for age 2, and
USA commercial LPUE indices through 1993 for ages 3-6.

ADAPT Run Number 361 1997 4 16 9 8 15

COD: GULF OF MAINE STOCK
COMMERCIAL LANDINGS ONLY
ALL INDICES UNWEIGHTED; NO TIME TAPERED WEIGHTING APPLIED
GMCOD97

Output option selected for input parameters: full
Output option selected for results: full

INPUT PARAMETERS AND OPTIONS SELECTED

Natural mortality is 0.2

Oldest age (not in the plus group) is 6

For all yrs prior to the terminal year (1996), backcalculated stock sizes for the following ages used to estimate total mortality (Z) for age 6: 4 5 6
This method for estimating F on the oldest age is generally used when a flat-topped partial recruitment curve is thought to be characteristic of the stock.

F for age 7+ is then calculated from the following ratios of F[age 7+] to F[age 6]

1982	1.0000
1983	1.0000
1984	1.0000
1985	1.0000
1986	1.0000
1987	1.0000
1988	1.0000
1989	1.0000
1990	1.0000
1991	1.0000
1992	1.0000
1993	1.0000
1994	1.0000
1995	1.0000
1996	1.0000

Stock size of the 7+ group is then calculated using the following method: CATCHEQ

Partial recruitment estimate for 1996

1	0.0001
2	0.0530
3	0.4210
4	1.0000
5	1.0000
6	1.0000

Objective function is SUM w*(LOG(OBS) - LOG(PRED))**2

Indices normalized (by dividing by mean observed value) before tuning to VPA stocksizes

The residuals for years prior to the terminal year are downweighted using the following algorithm: NONE

Biomass estimates (other than SSB) reflect mean stock sizes. SSB calculated as in the NEFSC projection program (see note below SSB table for description of the algorithm).

Initial estimates of parameters for the Marquardt algorithm
and lower and upper bounds on the parameter estimates:

Par.	Initial Est	Lower Bnd	Upper Bnd
N 2	3.000000E3	1.0000000E0	1.0000000E6
N 3	3.000000E3	1.0000000E0	1.0000000E6
N 4	5.000000E2	1.0000000E0	1.0000000E6
N 5	5.000000E2	1.0000000E0	1.0000000E6
N 6	5.000000E2	1.0000000E0	1.0000000E6
qRV SPR 2	1.000000E-2	0.0000000E0	1.0000000E0
qRV SPR 3	1.000000E-2	0.0000000E0	1.0000000E0
qRV SPR 4	1.000000E-2	0.0000000E0	1.0000000E0
qRV SPR 5	1.000000E-2	0.0000000E0	1.0000000E0
qRV SPR 6	1.000000E-2	0.0000000E0	1.0000000E0
qRV FAL 2	1.000000E-2	0.0000000E0	1.0000000E0
qRV FAL 3	1.000000E-2	0.0000000E0	1.0000000E0
qRV FAL 4	1.000000E-2	0.0000000E0	1.0000000E0
qRV FAL 5	1.000000E-2	0.0000000E0	1.0000000E0
qRV FAL 6	1.000000E-2	0.0000000E0	1.0000000E0
qCM CPE 3	1.000000E-2	0.0000000E0	1.0000000E0
qCM CPE 4	1.000000E-2	0.0000000E0	1.0000000E0
qCM CPE 5	1.000000E-2	0.0000000E0	1.0000000E0
qCM CPE 6	1.000000E-2	0.0000000E0	1.0000000E0
qMA SPR 2	1.000000E-2	0.0000000E0	1.0000000E0
qMA SPR 3	1.000000E-2	0.0000000E0	1.0000000E0
qMA SPR 4	1.000000E-2	0.0000000E0	1.0000000E0
qMA FAL 2	1.000000E-2	0.0000000E0	1.0000000E0

The following indices of abundance are available:

1 RV SPR 2
2 RV SPR 3
3 RV SPR 4
4 RV SPR 5
5 RV SPR 6
6 RV FAL 2
7 RV FAL 3
8 RV FAL 4
9 RV FAL 5
10 RV FAL 6
11 CM CPE 2
12 CM CPE 3
13 CM CPE 4
14 CM CPE 5
15 CM CPE 6
16 MA SPR 1
17 MA SPR 2
18 MA SPR 3
19 MA SPR 4
20 MA FAL 1
21 MA FAL 2
22 MA FAL 3
23
24
25
26
27
28
29
30

Indices that will be used in this run are: 1 2 3 4 5 6 7 8 9 10 12 13 14 15 17 18 19 21

Obs Indices (before transformation) by index & yr; with index means

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997*****
1 ■	1.019	0.978	1.033	0.238	0.330	0.638	1.053	0.649	0.190	0.209	0.230	0.500	0.316	0.180	0.020	-999.000 0.506
2 ■	0.516	0.833	1.147	0.622	0.647	0.486	0.633	0.790	1.327	0.355	0.240	0.800	0.387	1.120	0.590	-999.000 0.700
3 ■	0.694	0.641	0.741	0.665	0.387	0.300	0.355	0.632	0.627	1.477	0.280	0.330	0.213	0.370	1.330	-999.000 0.603
4 ■	0.864	0.357	0.190	0.677	0.074	0.128	0.217	0.090	0.167	0.268	1.310	0.090	0.095	0.150	0.040	-999.000 0.314
5 ■	0.117	0.181	0.053	0.095	0.046	0.011	0.087	0.077	0.032	0.024	0.220	0.480	0.047	0.030	0.060	-999.000 0.104
6 ■	0.619	0.700	1.660	0.384	0.378	0.301	0.599	1.951	0.416	0.029	0.142	0.290	0.198	0.210	0.070	0.120 0.504
7 ■	0.382	3.142	0.977	0.421	0.910	0.490	1.324	2.245	2.391	0.367	0.142	0.450	0.569	0.880	0.280	0.380 0.959
8 ■	0.549	2.473	0.852	0.565	0.763	0.654	0.600	0.960	1.356	1.643	0.221	0.140	0.363	0.830	1.232	0.190 0.837
9 ■	0.474	1.167	0.139	0.399	0.209	0.333	0.257	0.528	0.294	0.623	0.632	0.040	0.032	0.090	0.330	0.540 0.380
10 ■	0.089	0.248	0.264	0.220	0.218	0.086	0.061	0.110	0.174	0.278	0.079	0.330	0.000	0.050	0.080	0.060 0.156
12 ■	0.074	0.110	0.045	0.042	0.069	0.019	0.049	0.064	0.160	0.040	0.017	0.050	-999.000	-999.000	-999.000	-999.000 0.062
13 ■	0.045	0.042	0.044	0.029	0.023	0.026	0.024	0.040	0.078	0.136	0.014	0.023	-999.000	-999.000	-999.000	-999.000 0.044
14 ■	0.022	0.021	0.012	0.018	0.007	0.006	0.009	0.011	0.012	0.022	0.051	0.004	-999.000	-999.000	-999.000	-999.000 0.016
15 ■	0.003	0.012	0.006	0.004	0.004	0.002	0.001	0.002	0.005	0.004	0.005	0.014	-999.000	-999.000	-999.000	-999.000 0.005
17 ■	7.060	18.572	5.408	3.822	3.222	6.997	11.356	25.260	6.890	3.560	6.350	7.760	5.670	1.360	0.970	-999.000 7.617
18 ■	3.418	5.331	2.271	2.794	0.887	2.268	2.511	6.580	17.770	2.540	3.580	3.600	2.460	3.890	2.110	-999.000 4.134
19 ■	1.147	0.501	0.865	0.692	0.426	0.257	1.370	0.458	2.640	5.030	0.650	1.450	0.520	1.200	0.810	-999.000 1.201
21 ■	5.652	2.346	0.651	0.344	0.419	1.150	2.386	20.490	2.700	9.130	4.200	2.010	3.320	14.130	0.640	0.150 4.357

SUMMARY OF WEIGHTING USED IN THE OBJECTIVE FUNCTION

EXOGENOUS WEIGHTS BY INDEX AND YR (omega)

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1 ■	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-99.00	
2 ■	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-99.00	
3 ■	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-99.00	
4 ■	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-99.00	
5 ■	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-99.00	
6 ■	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
7 ■	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
8 ■	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
9 ■	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
10 ■	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
12 ■	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-99.00	
13 ■	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-99.00	
14 ■	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-99.00	
15 ■	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-99.00	
17 ■	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-99.00	
18 ■	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-99.00	
19 ■	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-99.00	
21 ■	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	

Negative weights in the above table indicate missing values

DOWNWEIGHTS BY YEAR (delta)

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
■	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

ITERATIVE RE-WEIGHTS BY INDEX (chi)

	1	2	3	4	5	6	7	8	9	10	12	13	14	15	17	18	19	21
■	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

FINAL SS WEIGHTS BY INDEX NUMBER AND YR - GMCOD97

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1 ■	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	-99.0000
2 ■	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	-99.0000
3 ■	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	-99.0000
4 ■	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	-99.0000
5 ■	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	-99.0000
6 ■	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7 ■	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
8 ■	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9 ■	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
10 ■	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	-99.0000	1.0000	1.0000	1.0000
12 ■	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
13 ■	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
14 ■	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
15 ■	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	-99.0000	-99.0000	-99.0000	-99.0000	-99.0000
17 ■	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	-99.0000
18 ■	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	-99.0000
19 ■	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	-99.0000
21 ■	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

Negative weights in the above table indicate missing values

CATCH AT AGE (thousands) - GMCOD97

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1 ■	30	0	4	0	0	2	0	0	0	0	0	0	0	0	0
2 ■	1380	866	446	407	84	216	160	337	205	344	313	76	29	218	65
3 ■	1633	2357	1240	1445	2164	595	1443	1583	3425	934	530	1487	1016	880	584
4 ■	1143	1058	1500	991	813	1109	953	1454	2064	4161	484	641	1135	1153	1738
5 ■	633	638	437	630	250	277	406	449	430	851	2018	129	288	194	347
6 ■	69	422	194	128	177	66	43	81	157	143	202	457	72	12	45
7 ■	230	155	136	136	95	79	30	56	99	79	84	36	86	34	10
1+■	5118	5496	3957	3737	3583	2344	3035	3960	6380	6512	3631	2826	2626	2491	2789

CAA summary for ages 2 5 3 5 4 5 5 5

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
2 ■	4789	4919	3623	3473	3311	2197	2962	3823	6124	6290	3345	2333	2468	2445	2734
3 ■	3409	4053	3177	3066	3227	1981	2802	3486	5919	5946	3032	2257	2439	2227	2669
4 ■	1776	1696	1937	1621	1063	1386	1359	1903	2494	5012	2502	770	1423	1347	2085
5 ■	633	638	437	630	250	277	406	449	430	851	2018	129	288	194	347

WT AT AGE (MID-YR) in kg. - GMCOD97

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1 ■	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900	0.900
2 ■	1.156	1.164	1.159	1.260	1.304	1.313	1.268	1.247	1.071	1.130	1.533	1.293	1.450	1.652	1.687
3 ■	1.664	1.660	1.670	1.746	1.837	1.684	1.881	1.776	1.692	1.568	1.922	1.889	1.943	1.921	2.136
4 ■	2.764	2.475	2.721	2.840	2.923	3.283	2.426	2.993	2.271	2.512	2.714	2.513	3.151	2.775	2.376
5 ■	4.770	3.778	3.677	4.466	4.619	4.831	5.166	3.864	4.265	4.136	3.061	4.356	3.444	5.142	3.648
6 ■	6.739	5.962	5.898	5.525	6.067	6.824	6.767	4.872	7.645	7.309	5.000	6.174	6.132	8.290	7.376
7 ■	11.309	9.756	10.187	9.764	10.243	10.313	11.512	12.179	13.732	11.449	10.614	11.064	10.018	12.965	11.649

WT AT AGE (JAN 1) in kg. - GMCOD97

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1 ■	0.791	0.793	0.761	0.748	0.745	0.758	0.765	0.825	0.803	0.690	0.751	0.709	0.664	0.657	0.657	0.739
2 ■	0.965	1.024	1.021	1.065	1.083	1.087	1.068	1.059	0.982	1.008	1.175	1.079	1.142	1.219	1.232	1.232
3 ■	1.364	1.385	1.394	1.423	1.521	1.482	1.572	1.501	1.453	1.296	1.474	1.702	1.585	1.669	1.878	2.310
4 ■	2.364	2.029	2.125	2.178	2.259	2.456	2.021	2.373	2.008	2.062	2.063	2.198	2.440	2.322	2.136	2.429
5 ■	4.267	3.231	3.017	3.486	3.622	3.758	4.118	3.062	3.573	3.065	2.773	3.438	2.942	4.025	3.182	2.642
6 ■	5.670	5.333	4.720	4.507	5.205	5.614	5.718	5.017	5.435	5.583	4.548	4.347	5.168	5.343	6.159	4.183
7 ■	11.309	9.756	10.187	9.764	10.243	10.313	11.512	12.179	13.732	11.449	10.614	11.064	10.018	12.965	11.649	11.649

Weights at age at the start of the spawning season are assumed to be the same as the Jan1 weight at age estimates.

PERCENT MATURE (females) - GMCOD97

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1 ■	7	7	7	4	4	4	4	9	9	9	9	9	9	9	9
2 ■	26	26	26	48	48	48	48	24	24	24	24	24	24	24	24
3 ■	61	61	61	95	95	95	95	54	54	54	54	54	54	54	54
4 ■	88	88	88	100	100	100	100	81	81	81	81	81	81	81	81
5 ■	97	97	97	100	100	100	100	94	94	94	94	94	94	94	94
6 ■	100	100	100	100	100	100	100	98	98	98	98	98	98	98	98
7 ■	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

SEX RATIO (Percent Female) - GMCOD97

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
--	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------

1 ■	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
2 ■	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
3 ■	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
4 ■	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
5 ■	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
6 ■	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
7 ■	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50

BEGIN MARQUARDT ALGORITHM

LAMBDA 1.00000E-2

RSS 3.00344E3

NPHI 3.00344E3

par

3.00000E3	3.00000E3	5.00000E2	5.00000E2	5.00000E2	1.00000E-2	1.00000E-2	1.00000E-2	1.00000E-2	1.00000E-2	1.00000E-2
1.00000E-2										
1.00000E-2										

LAMBDA 1.00000E-1

RSS 2.31612E3

NPHI 2.31612E3

par

2.56508E3	2.57276E3	5.51574E2	5.58491E2	4.49776E2	5.78612E-3	6.20138E-3	6.74726E-3	7.53569E-3	8.91658E-3
5.76161E-3	6.05487E-3	6.66827E-3	7.61226E-3	9.12623E-3	6.39222E-3	7.20220E-3	8.18280E-3	9.34452E-3	
5.82705E-3	6.05245E-3	6.58914E-3	5.47602E-3						

LAMBDA 1.00000E0

RSS 1.81344E3

NPHI 1.81344E3

par

2.22699E3	2.23906E3	5.98788E2	6.11512E2	4.04959E2	3.68622E-3	4.16251E-3	4.83699E-3	5.90988E-3	8.06442E-3
3.65986E-3	3.99162E-3	4.73909E-3	6.02504E-3	8.42830E-3	4.39139E-3	5.44038E-3	6.87254E-3	8.80057E-3	
3.73184E-3	3.98785E-3	4.63592E-3	3.35115E-3						

LAMBDA 1.00000E1

RSS 1.46858E3

NPHI 1.46858E3

par

1.92416E3	1.93950E3	6.16339E2	6.28190E2	3.54475E2	2.62204E-3	3.06800E-3	3.73375E-3	4.87950E-3	7.44511E-3
2.60106E-3	2.90817E-3	3.64751E-3	5.02902E-3	7.93016E-3	3.28045E-3	4.35823E-3	5.97233E-3	8.37898E-3	
2.66420E-3	2.90085E-3	3.52982E-3	2.32155E-3						

LAMBDA	1.00000E2								
RSS	1.31922E3								
NPHI	1.31922E3								
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par									
1.67968E3	1.69575E3	5.70654E2	5.69149E2	3.02395E2	2.25794E-3	2.68009E-3	3.31920E-3	4.46299E-3	7.17100E-3
2.23913E-3	2.52864E-3	3.24969E-3	4.64034E-3	7.71664E-3	2.87240E-3	3.93019E-3	5.58467E-3	8.17922E-3	
2.29757E-3	2.52061E-3	3.11994E-3	1.97859E-3						
<hr/>									
LAMBDA	1.00000E1								
RSS	1.05344E3								
NPHI	1.05344E3								
par									
1.15673E3	1.17135E3	4.16403E2	3.83131E2	1.85616E2	1.70121E-3	2.08861E-3	2.67650E-3	3.78980E-3	6.69324E-3
1.67656E-3	1.94180E-3	2.62463E-3	3.99232E-3	7.29189E-3	2.25710E-3	3.26491E-3	4.95894E-3	7.84151E-3	
1.73597E-3	1.94430E-3	2.48857E-3	1.45242E-3						
<hr/>									
LAMBDA	1.00000E2								
RSS	9.52183E2								
NPHI	9.52183E2								
par									
1.05232E3	1.06532E3	3.98278E2	3.69270E2	1.66381E2	1.50183E-3	1.86384E-3	2.42254E-3	3.51252E-3	6.47876E-3
1.48089E-3	1.72782E-3	2.38105E-3	3.72718E-3	7.12760E-3	2.01865E-3	2.99152E-3	4.68319E-3	7.68040E-3	
1.53431E-3	1.72756E-3	2.24185E-3	1.27263E-3						
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LAMBDA	1.00000E1								
RSS	7.76480E2								
NPHI	7.76480E2								
par									
8.06488E2	8.14246E2	3.17351E2	2.98267E2	1.20984E2	1.19243E-3	1.51653E-3	2.02473E-3	3.06347E-3	6.11284E-3
1.17264E-3	1.39270E-3	1.99616E-3	3.29156E-3	6.81400E-3	1.65137E-3	2.55981E-3	4.23395E-3	7.40767E-3	
1.22094E-3	1.39422E-3	1.85733E-3	9.92276E-4						
<hr/>									
LAMBDA	1.00000E2								
RSS	7.06077E2								
NPHI	7.06077E2								
par									
7.55653E2	7.62163E2	3.12011E2	2.98281E2	1.12993E2	1.07404E-3	1.37740E-3	1.86058E-3	2.87130E-3	5.94348E-3
1.05725E-3	1.26265E-3	1.83802E-3	3.10295E-3	6.68349E-3	1.50282E-3	2.37673E-3	4.03210E-3	7.27658E-3	
1.10077E-3	1.26181E-3	1.70011E-3	8.88778E-4						

LAMBDA	1.00000E1								
RSS	5.86076E2								
NPHI	5.86076E2								
par									
6.23591E2	6.25832E2	2.68001E2	2.66822E2	9.23577E1	8.87895E-4	1.15957E-3	1.60041E-3	2.55857E-3	5.65689E-3
8.73426E-4	1.05661E-3	1.58674E-3	2.79600E-3	6.44328E-3	1.26993E-3	2.08373E-3	3.70053E-3	7.05419E-3	
9.11616E-4	1.05527E-3	1.45193E-3	7.25241E-4						
LAMBDA	1.00000E0								
RSS	1.15175E2								
NPHI	1.15175E2								
par									
3.58091E2	3.53498E2	2.79218E2	3.22346E2	5.51918E1	1.38336E-4	2.50766E-4	4.90782E-4	1.18266E-3	4.30560E-3
1.45096E-4	2.17446E-4	5.09464E-4	1.41221E-3	5.38829E-3	2.95088E-4	8.08800E-4	2.18660E-3	5.97896E-3	
1.48629E-4	1.99536E-4	4.01380E-4	8.45688E-5						
LAMBDA	1.00000E-1								
RSS	9.48195E1								
NPHI	9.48195E1								
par									
5.79106E2	5.90639E2	7.00512E2	7.89769E2	8.43254E1	1.51728E-4	2.33182E-4	3.93746E-4	8.51742E-4	3.46225E-3
1.49966E-4	2.01941E-4	3.57590E-4	8.98423E-4	4.47309E-3	2.76533E-4	6.08136E-4	1.61017E-3	5.22378E-3	
1.58808E-4	2.00164E-4	3.38008E-4	1.07139E-4						
LAMBDA	1.00000E-2								
RSS	9.25340E1								
NPHI	9.25340E1								
par									
7.02535E2	7.15265E2	1.16645E3	1.19852E3	1.09625E2	1.49036E-4	2.25818E-4	3.90716E-4	8.65240E-4	3.44880E-3
1.45398E-4	1.95207E-4	3.61779E-4	9.43452E-4	4.38384E-3	2.75334E-4	6.16223E-4	1.63754E-3	5.20585E-3	
1.55226E-4	1.94710E-4	3.33773E-4	1.09400E-4						
LAMBDA	1.00000E-3								
RSS	9.24186E1								
NPHI	9.24186E1								
par									
7.20526E2	7.29815E2	1.34496E3	1.23975E3	1.21818E2	1.48398E-4	2.24996E-4	3.90367E-4	8.63385E-4	3.44184E-3
1.44791E-4	1.94534E-4	3.61517E-4	9.46532E-4	4.35408E-3	2.75293E-4	6.16269E-4	1.63773E-3	5.20538E-3	
1.54573E-4	1.93979E-4	3.33483E-4	1.08944E-4						

LAMBDA 1.00000E-4
RSS 9.24166E1
NPHI 9.24166E1

Par 7.21189E2 7.30181E2 1.36831E3 1.24270E3 1.24828E2 1.48299E-4 2.24846E-4 3.90271E-4 8.62910E-4 3.44017E-3
1.44695E-4 1.94408E-4 3.61265E-4 9.45910E-4 4.34659E-3 2.75284E-4 6.16257E-4 1.63769E-3 5.20529E-3
1.54470E-4 1.93850E-4 3.33401E-4 1.08872E-4

LAMBDA 1.00000E-5
RSS 9.24166E1
NPHI 9.24166E1

Par 7.21262E2 7.30254E2 1.36997E3 1.24398E3 1.25367E2 1.48284E-4 2.24824E-4 3.90246E-4 8.62821E-4 3.43984E-3
1.44680E-4 1.94388E-4 3.61219E-4 9.45758E-4 4.34502E-3 2.75283E-4 6.16255E-4 1.63768E-3 5.20527E-3
1.54454E-4 1.93831E-4 3.33380E-4 1.08860E-4

RELATIVE CHANGE IN RESIDUAL SUM OF SQUARES LESS THAN 0.00001

RESULTS

APPROXIMATE STATISTICS ASSUMING LINEARITY NEAR SOLUTION

SUM OF SQUARES	92.416601
ORTHOGONALITY OFFSET.....	0.002585
MEAN SQUARE RESIDUALS	0.385069

	PAR. EST.	STD. ERR.	T-STATISTIC	C.V.
N 2	7.21262E2	3.29056E2	2.19191E0	0.46
N 3	7.30254E2	2.24368E2	3.25471E0	0.31
N 4	1.36997E3	4.25191E2	3.22201E0	0.31
N 5	1.24398E3	5.05247E2	2.46212E0	0.41
N 6	1.25367E2	7.18052E1	1.74593E0	0.57
qRV SPR 2	1.48284E-4	2.42032E-5	6.12665E0	0.16
qRV SPR 3	2.24824E-4	3.64429E-5	6.16921E0	0.16
qRV SPR 4	3.90246E-4	6.30466E-5	6.18981E0	0.16
qRV SPR 5	8.62821E-4	1.39447E-4	6.18746E0	0.16
qRV SPR 6	3.43984E-3	5.55621E-4	6.19098E0	0.16
qRV FAL 2	1.44680E-4	2.32530E-5	6.22200E0	0.16
qRV FAL 3	1.94388E-4	3.07506E-5	6.32144E0	0.16
qRV FAL 4	3.61219E-4	5.69530E-5	6.34240E0	0.16
qRV FAL 5	9.45758E-4	1.50098E-4	6.30094E0	0.16
qRV FAL 6	4.34502E-3	7.32247E-4	5.93381E0	0.17
qCM CPE 3	2.75283E-4	4.95592E-5	5.55463E0	0.18
qCM CPE 4	6.16255E-4	1.10944E-4	5.55466E0	0.18
qCM CPE 5	1.63768E-3	2.94830E-4	5.55464E0	0.18
qCM CPE 6	5.20527E-3	9.37100E-4	5.55466E0	0.18
qMA SPR 2	1.54454E-4	2.52103E-5	6.12665E0	0.16
qMA SPR 3	1.93831E-4	3.14191E-5	6.16921E0	0.16
qMA SPR 4	3.33380E-4	5.38595E-5	6.18981E0	0.16
qMA FAL 2	1.08860E-4	1.74961E-5	6.22200E0	0.16

CATCHABILITY ESTIMATES IN ORIGINAL UNITS

	ESTIMATE	STD. ERR.	C.V.
qRV SPR 2	7.49741E-5	1.22374E-5	0.16
qRV SPR 3	1.57272E-4	2.54931E-5	0.16
qRV SPR 4	2.35263E-4	3.80081E-5	0.16
qRV SPR 5	2.71319E-4	4.38498E-5	0.16
qRV SPR 6	3.57788E-4	5.77919E-5	0.16
qRV FAL 2	7.29443E-5	1.17236E-5	0.16
qRV FAL 3	1.86478E-4	2.94993E-5	0.16
qRV FAL 4	3.02327E-4	4.76676E-5	0.16
qRV FAL 5	3.59762E-4	5.70966E-5	0.16
qRV FAL 6	6.79688E-4	1.14545E-4	0.17
qCM CPE 3	1.69371E-5	3.04919E-6	0.18
qCM CPE 4	2.68792E-5	4.83904E-6	0.18
qCM CPE 5	2.64476E-5	4.76660E-6	0.18
qCM CPE 6	2.69298E-5	4.84814E-6	0.18
qMA SPR 2	1.17650E-3	1.92030E-4	0.16
qMA SPR 3	8.01297E-4	1.29886E-4	0.16
qMA SPR 4	4.00411E-4	6.46888E-5	0.16
qMA FAL 2	4.74346E-4	7.62369E-5	0.16

CORRELATION BETWEEN PARAMETERS ESTIMATED

1.00	0.04	0.03	0.02	0.01	-0.01	-0.00	-0.00	-0.00	-0.19	-0.01	-0.01	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.19
0.04	1.00	0.05	0.04	0.01	-0.12	-0.01	-0.00	-0.00	-0.13	-0.13	-0.01	-0.01	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.12	-0.01	-0.00	-0.00	-0.13	
0.03	0.05	1.00	0.05	0.01	-0.09	-0.10	-0.00	-0.00	-0.10	-0.10	-0.13	-0.01	-0.01	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00	-0.09	-0.10	-0.00	-0.10	-0.00	
0.02	0.04	0.05	1.00	-0.00	-0.07	-0.07	-0.08	-0.01	-0.03	-0.07	-0.07	-0.08	-0.17	-0.03	-0.00	-0.00	-0.00	-0.00	-0.00	-0.07	-0.07	-0.08	-0.07	-0.07	
0.01	0.01	0.01	-0.00	1.00	-0.02	-0.02	-0.03	-0.09	-0.07	-0.02	-0.02	-0.03	-0.08	-0.29	-0.00	-0.00	-0.00	-0.00	-0.00	-0.02	-0.02	-0.03	-0.02	-0.02	
-0.01	-0.12	-0.09	-0.07	-0.02	1.00	0.01	0.01	0.00	0.00	0.03	0.03	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.03	0.01	0.01	0.03	0.01	0.03	
-0.00	-0.01	-0.10	-0.07	-0.02	0.01	1.00	0.01	0.00	0.00	0.01	0.01	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	
-0.00	-0.00	-0.00	-0.08	-0.03	0.01	0.01	1.00	0.00	0.00	0.01	0.01	0.01	0.02	0.01	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	
-0.00	-0.00	-0.00	-0.01	-0.09	0.00	0.00	0.00	1.00	0.01	0.00	0.00	0.01	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
-0.00	-0.00	-0.00	-0.03	-0.07	0.00	0.00	0.00	0.01	1.00	0.00	0.00	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
-0.19	-0.13	-0.10	-0.07	-0.02	0.03	0.01	0.01	0.00	0.00	1.00	0.03	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.03	0.01	0.01	0.06	0.01	0.03	
-0.01	-0.13	-0.10	-0.07	-0.02	0.03	0.01	0.01	0.00	0.00	0.03	1.00	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.03	0.01	0.01	0.03	0.01	0.03	
-0.01	-0.01	-0.13	-0.08	-0.03	0.02	0.02	0.01	0.00	0.00	0.02	0.02	1.00	0.02	0.01	0.00	0.00	0.00	0.00	0.02	0.02	0.01	0.02	0.02	0.02	
-0.00	-0.01	-0.01	-0.17	-0.08	0.01	0.01	0.02	0.01	0.01	0.01	0.02	1.00	0.03	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.01	0.01	0.02	0.01	
-0.00	-0.00	-0.01	-0.03	-0.29	0.01	0.01	0.01	0.03	0.02	0.01	0.01	0.03	1.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	
-0.00	-0.00	-0.00	-0.00	-0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
-0.00	-0.00	-0.00	-0.00	-0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
-0.00	-0.00	-0.00	-0.00	-0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
-0.00	-0.00	-0.00	-0.00	-0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
-0.01	-0.12	-0.09	-0.07	-0.02	0.03	0.01	0.01	0.00	0.00	0.03	0.03	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.01	0.03	
-0.00	-0.01	-0.10	-0.07	-0.02	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.01	1.00	0.01	0.01	0.01		
-0.00	-0.00	-0.00	-0.08	-0.03	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.01	1.00	0.01	0.01		
-0.19	-0.13	-0.10	-0.07	-0.02	0.03	0.01	0.01	0.00	0.00	0.06	0.03	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.03	0.01	0.01	1.00	0.01		

CORRELATION BETWEEN PARAMETERS ESTIMATED (SYMBOLIC FORM)

N 2	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
N 3	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
N 4	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
N 5	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
N 6	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
qRV SPR 2	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
qRV SPR 3	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
qRV SPR 4	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
qRV SPR 5	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
qRV SPR 6	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
qRV FAL 2	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
qRV FAL 3	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
qRV FAL 4	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
qRV FAL 5	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
qRV FAL 6	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
qCM CPE 3	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
qCM CPE 4	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.
qCM CPE 5	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.
qCM CPE 6	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.
QMA SPR 2	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.
QMA SPR 3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.
QMA SPR 4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.
QMA FAL 2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.

SYMBOLS: = LARGE NEGATIVE CORRELATION Whenever $-1 \leq R < -L$
 - MODERATE NEGATIVE CORRELATION Whenever $-L \leq R < -M$
 . SMALL CORRELATION Whenever $-M \leq R \leq +M$
 + MODERATE POSITIVE CORRELATION Whenever $+M < R \leq +L$
 * LARGE POSITIVE CORRELATION Whenever $+L < R \leq +1$

Where R is the estimated correlation, M is 0.2 and L is 0.5

SUMMARY OF RESIDUALS

Index 1 RV SPR 2

Index is tuned to the sum of Jan1 full stock sizes (in number)

for ages: 2

SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	0.7010	0.3005	1.0000	0.4005	0.6454	9107.659
1983	0.6599	-0.2956	1.0000	0.9555	1.5398	5017.878
1984	0.7142	-0.3978	1.0000	1.1120	1.7920	4530.472
1985	-0.7535	-0.0620	1.0000	-0.6915	-1.1144	6338.648
1986	-0.4267	-0.5166	1.0000	0.0900	0.1450	4022.788
1987	0.2326	-0.1058	1.0000	0.3384	0.5453	6066.650
1988	0.7336	0.1891	1.0000	0.5445	0.8775	8147.605
1989	0.2503	0.9662	1.0000	-0.7159	-1.1537	17721.445
1990	-0.9767	-0.8929	1.0000	-0.0838	-0.1350	2761.393
1991	-0.8818	-0.8876	1.0000	0.0059	0.0095	2775.918
1992	-0.7877	-0.3428	1.0000	-0.4449	-0.7170	4786.727
1993	-0.0112	-0.4421	1.0000	0.4309	0.6944	4334.207
1994	-0.4700	-0.0598	1.0000	-0.4102	-0.6610	6352.080
1995	-1.0328	-0.7860	1.0000	-0.2468	-0.3978	3072.999
1996	-3.2300	-1.9455	1.0000	-1.2845	-2.0700	963.770

Partial variance for this index is 0.436486

Index 2 RV SPR 3

Index is tuned to the sum of Jan1 full stock sizes (in number)

for ages: 3

SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	-0.3036	-0.0273	1.0000	-0.2763	-0.4453	4328.310
1983	0.1747	0.3334	1.0000	-0.1587	-0.2558	6208.045
1984	0.4941	-0.2911	1.0000	0.7852	1.2653	3324.702
1985	-0.1175	-0.2968	1.0000	0.1793	0.2890	3305.679
1986	-0.0781	0.0806	1.0000	-0.1587	-0.2557	4821.377
1987	-0.3642	-0.3238	1.0000	-0.0404	-0.0651	3217.574
1988	-0.0999	0.0702	1.0000	-0.1702	-0.2742	4771.508
1989	0.1216	0.3833	1.0000	-0.2617	-0.4218	6525.920
1990	0.6404	1.1611	1.0000	-0.5207	-0.8391	14204.162
1991	-0.6791	-0.7623	1.0000	0.0832	0.1341	2075.346
1992	-1.0698	-0.8187	1.0000	-0.2510	-0.4045	1961.465
1993	0.1342	-0.2016	1.0000	0.3358	0.5411	3635.826
1994	-0.5917	-0.2455	1.0000	-0.3463	-0.5580	3479.781
1995	0.4707	0.1513	1.0000	0.3194	0.5147	5174.403
1996	-0.1703	-0.6514	1.0000	0.4811	0.7754	2318.704

Partial variance for this index is 0.129842

Index 3 RV SPR 4

Index is tuned to the sum of Jan1 full stock sizes (in number)

for ages: 4

SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	0.1406	0.0397	1.0000	0.1009	0.1626	2666.212
1983	0.0616	-0.2153	1.0000	0.2769	0.4462	2066.121
1984	0.2063	0.1408	1.0000	0.0655	0.1055	2950.015
1985	0.0981	-0.4710	1.0000	0.5691	0.9170	1600.037
1986	-0.4433	-0.6052	1.0000	0.1620	0.2610	1398.971
1987	-0.6979	-0.2532	1.0000	-0.4447	-0.7167	1989.342
1988	-0.5296	-0.2010	1.0000	-0.3286	-0.5295	2095.949
1989	0.0472	0.0149	1.0000	0.0323	0.0521	2600.900
1990	0.0397	0.4227	1.0000	-0.3830	-0.6173	3910.614
1991	0.8963	1.2026	1.0000	-0.3064	-0.4937	8530.316
1992	-0.7669	-1.0988	1.0000	0.3319	0.5348	854.031
1993	-0.6026	-0.8220	1.0000	0.2194	0.3536	1126.548
1994	-1.0390	-0.4516	1.0000	-0.5874	-0.9465	1631.269
1995	-0.4882	-0.2836	1.0000	-0.2046	-0.3296	1929.689
1996	0.7913	0.2945	1.0000	0.4967	0.8004	3440.186

Partial variance for this index is 0.129747

Index 4 RV SPR 5

Index is tuned to the sum of Jan1 full stock sizes (in number)

for ages: 5

SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	1.0106	0.3599	1.0000	0.6507	1.0486	1661.084
1983	0.1276	-0.0089	1.0000	0.1365	0.2200	1148.680
1984	-0.5021	-0.4564	1.0000	-0.0457	-0.0737	734.279
1985	0.7668	-0.0912	1.0000	0.8580	1.3826	1058.012
1986	-1.4468	-1.0311	1.0000	-0.4157	-0.6698	413.306
1987	-0.8988	-1.0398	1.0000	0.1409	0.2271	409.748
1988	-0.3709	-0.6171	1.0000	0.2462	0.3967	625.271
1989	-1.2504	-0.3057	1.0000	-0.9447	-1.5223	853.708
1990	-0.6347	-0.3536	1.0000	-0.2811	-0.4530	813.803
1991	-0.1606	0.1408	1.0000	-0.3013	-0.4856	1334.156
1992	1.4269	1.0215	1.0000	0.4054	0.6533	3219.004
1993	-1.2510	-1.4897	1.0000	0.2387	0.3846	261.280
1994	-1.1991	-1.2200	1.0000	0.0209	0.0337	342.175
1995	-0.7402	-1.3233	1.0000	0.5831	0.9397	308.580
1996	-2.0620	-0.7700	1.0000	-1.2919	-2.0820	536.618

Partial variance for this index is 0.34445

Index 5 RV SPR 6

Index is tuned to the sum of Jan1 full stock sizes (in number)

for ages: 6

SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	0.1183	-0.5593	1.0000	0.6776	1.0920	166.175
1983	0.5538	0.9962	1.0000	-0.4424	-0.7130	787.219
1984	-0.6735	0.2225	1.0000	-0.8960	-1.4439	363.174
1985	-0.0906	-0.3456	1.0000	0.2550	0.4109	205.763
1986	-0.8159	0.0186	1.0000	-0.8345	-1.3448	296.179
1987	-2.2466	-0.9523	1.0000	-1.2944	-2.0859	112.177
1988	-0.1786	-1.2316	1.0000	1.0530	1.6970	84.833
1989	-0.3055	-0.6986	1.0000	0.3931	0.6334	144.564
1990	-1.1667	0.0068	1.0000	-1.1734	-1.8910	292.685
1991	-1.4790	-0.0476	1.0000	-1.4315	-2.3068	277.206
1992	0.7491	0.1031	1.0000	0.6460	1.0410	322.298
1993	1.5293	1.0241	1.0000	0.5051	0.8140	809.535
1994	-0.7859	-1.0956	1.0000	0.3097	0.4991	97.194
1995	-1.2433	-2.6990	1.0000	1.4557	2.3459	19.556
1996	-0.5502	-1.3272	1.0000	0.7770	1.2521	77.105

Partial variance for this index is 0.879973

Index 6 RV FAL 2

Index is tuned to the sum of Jan1 full stock sizes (in number)

for ages: 2

SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	0.2057	0.2759	1.0000	-0.0702	-0.1131	9107.659
1983	0.3288	-0.3202	1.0000	0.6490	1.0459	5017.878
1984	1.1915	-0.4224	1.0000	1.6140	2.6009	4530.472
1985	-0.2729	-0.0866	1.0000	-0.1863	-0.3003	6338.648
1986	-0.2880	-0.5413	1.0000	0.2532	0.4081	4022.788
1987	-0.5158	-0.1304	1.0000	-0.3854	-0.6211	6066.650
1988	0.1723	0.1645	1.0000	0.0078	0.0126	8147.605
1989	1.3532	0.9415	1.0000	0.4116	0.6633	17721.445
1990	-0.1933	-0.9175	1.0000	0.7241	1.1670	2761.393
1991	-2.8477	-0.9123	1.0000	-1.9355	-3.1190	2775.918
1992	-1.2657	-0.3674	1.0000	-0.8983	-1.4476	4786.727
1993	-0.5530	-0.4667	1.0000	-0.0864	-0.1392	4334.207
1994	-0.9372	-0.0844	1.0000	-0.8527	-1.3742	6352.080
1995	-0.8758	-0.8106	1.0000	-0.0652	-0.1051	3072.999
1996	-1.9744	-1.9701	1.0000	-0.0043	-0.0069	963.770
1997	-1.4354	-2.2600	1.0000	0.8245	1.3288	721.262

Partial variance for this index is 0.675446

Index 7 RV FAL 3

Index is tuned to the sum of Jan1 full stock sizes (in number)

for ages: 3

SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	-0.9203	-0.1727	1.0000	-0.7475	-1.2047	4328.310
1983	1.1864	0.1879	1.0000	0.9984	1.6089	6208.045
1984	0.0178	-0.4365	1.0000	0.4543	0.7322	3324.702
1985	-0.8231	-0.4423	1.0000	-0.3808	-0.6137	3305.679
1986	-0.0528	-0.0648	1.0000	0.0121	0.0195	4821.377
1987	-0.6718	-0.4693	1.0000	-0.2025	-0.3264	3217.574
1988	0.3222	-0.0752	1.0000	0.3974	0.6405	4771.508
1989	0.8503	0.2379	1.0000	0.6124	0.9868	6525.920
1990	0.9131	1.0156	1.0000	-0.1026	-0.1653	14204.162
1991	-0.9620	-0.9078	1.0000	-0.0543	-0.0875	2075.346
1992	-1.9090	-0.9642	1.0000	-0.9448	-1.5225	1961.465
1993	-0.7570	-0.3471	1.0000	-0.4099	-0.6606	3635.826
1994	-0.5227	-0.3909	1.0000	-0.1318	-0.2123	3479.781
1995	-0.0863	0.0058	1.0000	-0.0921	-0.1484	5174.403
1996	-1.2314	-0.7969	1.0000	-0.4345	-0.7002	2318.704
1997	-0.9260	-1.9523	1.0000	1.0262	1.6538	730.254

Partial variance for this index is 0.327606

Index 8 RV FAL 4

Index is tuned to the sum of Jan1 full stock sizes (in number)

for ages: 4

SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	-0.4215	-0.0376	1.0000	-0.3839	-0.6186	2666.212
1983	1.0832	-0.2926	1.0000	1.3758	2.2172	2066.121
1984	0.0175	0.0635	1.0000	-0.0460	-0.0742	2950.015
1985	-0.3935	-0.5482	1.0000	0.1548	0.2494	1600.037
1986	-0.0925	-0.6825	1.0000	0.5900	0.9508	1398.971
1987	-0.2467	-0.3305	1.0000	0.0838	0.1350	1989.342
1988	-0.3329	-0.2783	1.0000	-0.0546	-0.0880	2095.949
1989	0.1372	-0.0624	1.0000	0.1996	0.3216	2600.900
1990	0.4828	0.3454	1.0000	0.1374	0.2214	3910.614
1991	0.6746	1.1254	1.0000	-0.4507	-0.7264	8530.316
1992	-1.3307	-1.1761	1.0000	-0.1547	-0.2492	854.031
1993	-1.7881	-0.8993	1.0000	-0.8888	-1.4324	1126.348
1994	-0.8343	-0.5289	1.0000	-0.3054	-0.4921	1631.269
1995	-0.0084	-0.3609	1.0000	0.3526	0.5681	1929.689
1996	0.3866	0.2173	1.0000	0.1694	0.2729	3440.186
1997	-1.4828	-0.7035	1.0000	-0.7793	-1.2558	1369.969

Partial variance for this index is 0.295731

Index 9 RV FAL 5

Index is tuned to the sum of Jan1 full stock sizes (in number)

for ages: 5

SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	0.2205	0.4517	1.0000	-0.2312	-0.3726	1661.084
1983	1.1209	0.0828	1.0000	1.0380	1.6728	1148.680
1984	-1.0079	-0.3646	1.0000	-0.6433	-1.0366	734.279
1985	0.0487	0.0006	1.0000	0.0480	0.0774	1058.012
1986	-0.5989	-0.9393	1.0000	0.3405	0.5487	413.306
1987	-0.1331	-0.9480	1.0000	0.8149	1.3132	409.748
1988	-0.3921	-0.5253	1.0000	0.1332	0.2147	625.271
1989	0.3279	-0.2139	1.0000	0.5418	0.8731	853.708
1990	-0.2580	-0.2618	1.0000	0.0038	0.0061	813.803
1991	0.4926	0.2325	1.0000	0.2600	0.4190	1334.156
1992	0.5077	1.1133	1.0000	-0.6056	-0.9760	3219.004
1993	-2.2523	-1.3979	1.0000	-0.8544	-1.3769	261.280
1994	-2.4881	-1.1282	1.0000	-1.3599	-2.1914	342.175
1995	-1.4414	-1.2315	1.0000	-0.2099	-0.3382	308.580
1996	-0.1421	-0.6782	1.0000	0.5361	0.8640	536.618
1997	0.3504	0.1625	1.0000	0.1878	0.3027	1243.978

Partial variance for this index is 0.408818

Index 10 RV FAL 6

Index is tuned to the sum of Jan1 full stock sizes (in number)

for ages: 6

SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	-0.5649	-0.3257	1.0000	-0.2392	-0.3854	166.175
1983	0.4610	1.2298	1.0000	-0.7688	-1.2389	787.219
1984	0.5220	0.4562	1.0000	0.0658	0.1061	363.174
1985	0.3408	-0.1120	1.0000	0.4528	0.7298	205.763
1986	0.3319	0.2522	1.0000	0.0797	0.1284	296.179
1987	-0.5983	-0.7186	1.0000	0.1204	0.1940	112.177
1988	-0.9417	-0.9980	1.0000	0.0563	0.0907	84.833
1989	-0.3521	-0.4650	1.0000	0.1129	0.1819	144.564
1990	0.1053	0.2404	1.0000	-0.1351	-0.2177	292.685
1991	0.5753	0.1860	1.0000	0.3893	0.6273	277.206
1992	-0.6832	0.3367	1.0000	-0.1099	-1.6436	322.298
1993	0.7465	1.2577	1.0000	-0.5112	-0.8239	809.535
1995	-1.1406	-2.4654	1.0000	1.3249	2.1350	19.556
1996	-0.6706	-1.0936	1.0000	0.4230	0.6816	77.105
1997	-0.9583	-0.6075	1.0000	-0.3508	-0.5653	125.367

Partial variance for this index is 0.32232

Index 12 CM CPE 3

Index is tuned to the sum of mean full stock sizes (in number)

for ages: 3

SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	0.1822	-0.1718	1.0000	0.3540	0.5705	3059.062
1983	0.5802	0.1868	1.0000	0.3934	0.6339	4378.862
1984	-0.3178	-0.4321	1.0000	0.1143	0.1841	2358.183
1985	-0.3755	-0.4936	1.0000	0.1181	0.1903	2217.348
1986	0.1113	-0.1271	1.0000	0.2384	0.3842	3199.115
1987	-1.1957	-0.3280	1.0000	-0.8678	-1.3984	2616.821
1988	-0.2235	-0.0154	1.0000	-0.2081	-0.3353	3577.110
1989	0.0347	0.3407	1.0000	-0.3060	-0.4932	5107.147
1990	0.9528	1.1194	1.0000	-0.1667	-0.2686	11127.182
1991	-0.4197	-0.9711	1.0000	0.5514	0.8886	1375.486
1992	-1.2671	-0.8808	1.0000	-0.3862	-0.6224	1505.499
1993	-0.2080	-0.3732	1.0000	0.1652	0.2663	2501.076

Partial variance for this index is 0.164347

Index 13 CM CPE 4

Index is tuned to the sum of mean full stock sizes (in number)

for ages: 4

SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	0.0317	0.1049	1.0000	-0.0733	-0.1180	1802.198
1983	-0.0341	-0.2315	1.0000	0.1974	0.3180	1287.377
1984	0.0128	0.1284	1.0000	-0.1157	-0.1864	1845.103
1985	-0.4101	-0.6157	1.0000	0.2055	0.3312	876.726
1986	-0.6590	-0.7003	1.0000	0.0413	0.0666	805.589
1987	-0.5177	-0.3198	1.0000	-0.1979	-0.3189	1178.591
1988	-0.5898	-0.1598	1.0000	-0.4300	-0.6929	1383.076
1989	-0.0952	-0.0536	1.0000	-0.0416	-0.0671	1538.089
1990	0.5833	0.3896	1.0000	0.1936	0.3120	2395.823
1991	1.1336	1.2115	1.0000	-0.0779	-0.1256	5449.990
1992	-1.1507	-1.1763	1.0000	0.0256	0.0412	500.476
1993	-0.6295	-0.9024	1.0000	0.2729	0.4398	658.187

Partial variance for this index is 0.041607

Index 14 CM CPE 5

Index is tuned to the sum of mean full stock sizes (in number)

for ages: 5

SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	0.2935	0.6505	1.0000	-0.3570	-0.5753	1170.273
1983	0.2584	0.1108	1.0000	0.1476	0.2379	682.167
1984	-0.3157	-0.3851	1.0000	0.0695	0.1119	415.446
1985	0.1033	-0.0203	1.0000	0.1236	0.1992	598.369
1986	-0.8937	-0.9725	1.0000	0.0787	0.1269	230.908
1987	-1.0393	-1.0851	1.0000	0.0457	0.0737	206.314
1988	-0.5511	-0.6207	1.0000	0.0696	0.1122	328.248
1989	-0.4228	-0.1528	1.0000	-0.2699	-0.4350	524.079
1990	-0.2820	-0.2034	1.0000	-0.0786	-0.1267	498.252
1991	0.2942	0.1540	1.0000	0.1402	0.2259	712.286
1992	1.1580	1.0503	1.0000	0.1077	0.1735	1745.528
1993	-1.3800	-1.3029	1.0000	-0.0771	-0.1242	165.931

Partial variance for this index is 0.02786

Index 15 CM CPE 6

Index is tuned to the sum of mean full stock sizes (in number)

for ages: 6

SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	-0.6697	-0.5246	1.0000	-0.1450	-0.2337	113.686
1983	0.8666	0.9113	1.0000	-0.0448	-0.0721	477.908
1984	0.0652	0.1398	1.0000	-0.0746	-0.1202	220.939
1985	-0.3611	-0.5367	1.0000	0.1755	0.2829	112.326
1986	-0.1896	-0.1398	1.0000	-0.0498	-0.0802	167.044
1987	-1.0740	-1.0989	1.0000	0.0249	0.0401	64.018
1988	-1.2612	-1.2850	1.0000	0.0238	0.0383	53.148
1989	-0.8068	-0.8112	1.0000	0.0043	0.0070	85.364
1990	-0.0144	-0.0785	1.0000	0.0641	0.1032	177.615
1991	-0.2711	-0.1104	1.0000	-0.1607	-0.2590	172.030
1992	0.0029	-0.0944	1.0000	0.0973	0.1568	174.805
1993	0.9916	0.9066	1.0000	0.0850	0.1370	475.646

Partial variance for this index is 0.010232

Index 17 MA SPR 2

Index is tuned to the sum of Jan1 full stock sizes (in number)

for ages: 2

SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	-0.0760	0.3413	1.0000	-0.4172	-0.6723	9107.659
1983	0.8913	-0.2548	1.0000	1.1461	1.8469	5017.878
1984	-0.3425	-0.3570	1.0000	0.0145	0.0234	4530.472
1985	-0.6896	-0.0212	1.0000	-0.6684	-1.0772	6338.648
1986	-0.8604	-0.4759	1.0000	-0.3845	-0.6196	4022.788
1987	-0.0849	-0.0651	1.0000	-0.0199	-0.0320	6066.650
1988	0.3993	0.2299	1.0000	0.1695	0.2731	8147.605
1989	1.1988	1.0069	1.0000	0.1919	0.3093	17721.445
1990	-0.1003	-0.8521	1.0000	0.7518	1.2115	2761.393
1991	-0.7606	-0.8469	1.0000	0.0862	0.1390	2775.918
1992	-0.1819	-0.3020	1.0000	0.1201	0.1935	4786.727
1993	0.0186	-0.4013	1.0000	0.4199	0.6767	4334.207
1994	-0.2952	-0.0191	1.0000	-0.2761	-0.4450	6352.080
1995	-1.7229	-0.7452	1.0000	-0.9777	-1.5756	3072.999
1996	-2.0609	-1.9048	1.0000	-0.1561	-0.2516	963.770

Partial variance for this index is 0.289191

Index 18 MA SPR 3

Index is tuned to the sum of Jan1 full stock sizes (in number)

for ages: 3

SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	-0.1902	-0.1756	1.0000	-0.0146	-0.0235	4328.310
1983	0.2543	0.1851	1.0000	0.0692	0.1115	6208.045
1984	-0.5990	-0.4394	1.0000	-0.1596	-0.2573	3324.702
1985	-0.3918	-0.4451	1.0000	0.0534	0.0860	3305.679
1986	-1.5392	-0.0677	1.0000	-1.4714	-2.3712	4821.377
1987	-0.6003	-0.4721	1.0000	-0.1282	-0.2066	3217.574
1988	-0.4986	-0.0781	1.0000	-0.4205	-0.6776	4771.508
1989	0.4648	0.2350	1.0000	0.2298	0.3703	6525.920
1990	1.4583	1.0128	1.0000	0.4455	0.7179	14204.162
1991	-0.4871	-0.9106	1.0000	0.4236	0.6826	2075.346
1992	-0.1439	-0.9671	1.0000	0.8232	1.3266	1961.465
1993	-0.1383	-0.3499	1.0000	0.2116	0.3410	3635.826
1994	-0.5191	-0.3938	1.0000	-0.1253	-0.2019	3479.781
1995	-0.0608	0.0030	1.0000	-0.0638	-0.1028	5174.403
1996	-0.6726	-0.7998	1.0000	0.1272	0.2050	2318.704

Partial variance for this index is 0.260946

Index 19 MA SPR 4

Index is tuned to the sum of Jan1 full stock sizes (in number)

for ages: 4

SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	-0.0461	-0.1178	1.0000	0.0718	0.1156	2666.212
1983	-0.8744	-0.3728	1.0000	-0.5016	-0.8083	2066.121
1984	-0.3282	-0.0167	1.0000	-0.3116	-0.5021	2950.015
1985	-0.5514	-0.6284	1.0000	0.0771	0.1242	1600.037
1986	-0.10365	-0.7627	1.0000	-0.2738	-0.4412	1398.971
1987	-1.5419	-0.4107	1.0000	-1.1312	-1.8230	1989.342
1988	0.1316	-0.3585	1.0000	0.4901	0.7897	2095.949
1989	-0.9641	-0.1426	1.0000	-0.8215	-1.3238	2600.900
1990	0.7876	0.2652	1.0000	0.5223	0.8418	3910.614
1991	1.4322	1.0452	1.0000	0.3871	0.6237	8530.316
1992	-0.6140	-1.2563	1.0000	0.6423	1.0350	854.031
1993	0.1884	-0.9795	1.0000	1.1678	1.8820	1126.348
1994	-0.8371	-0.6091	1.0000	-0.2280	-0.3675	1631.269
1995	-0.0009	-0.4411	1.0000	0.4402	0.7094	1929.689
1996	-0.3939	0.1371	1.0000	-0.5310	-0.8557	3440.186

Partial variance for this index is 0.390324

Index 21 MA FAL 2

Index is tuned to the sum of Jan1 full stock sizes (in number)

for ages: 2

SORTED BY YEAR

Yr	Observed	Pred	Weight	Wt Res	Std Res	Pred Stocksize
1982	0.2601	-0.0086	1.0000	0.2687	0.4330	9107.659
1983	-0.6192	-0.6047	1.0000	-0.0145	-0.0233	5017.878
1984	-1.9011	-0.7069	1.0000	-1.1943	-1.9245	4530.472
1985	-2.5390	-0.3710	1.0000	-2.1680	-3.4937	6338.648
1986	-2.3418	-0.8257	1.0000	-1.5160	-2.4431	4022.788
1987	-1.3321	-0.4149	1.0000	-0.9172	-1.4781	6066.650
1988	-0.6023	-0.1200	1.0000	-0.4823	-0.7772	8147.605
1989	1.5481	0.6571	1.0000	0.8910	1.4358	17721.445
1990	-0.4786	-1.2020	1.0000	0.7233	1.1657	2761.393
1991	0.7397	-1.1967	1.0000	1.9364	3.1205	2775.918
1992	-0.0368	-0.6518	1.0000	0.6151	0.9912	4786.727
1993	-0.7737	-0.7511	1.0000	-0.0226	-0.0364	4334.207
1994	-0.2719	-0.3689	1.0000	0.0970	0.1563	6352.080
1995	1.1764	-1.0950	1.0000	2.2715	3.6605	3072.999
1996	-1.9182	-2.2546	1.0000	0.3364	0.5422	963.770
1997	-3.3690	-2.5444	1.0000	-0.8245	-1.3288	721.262

Partial variance for this index is 1.424958

Standardized residuals by index & yr; with row/column/grand means

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1 ■	0.6454	1.5398	1.7920	-1.1144	0.1450	0.5453	0.8775	-1.1537	-0.1350	0.0095	-0.7170	0.6944	-0.6610	-0.3978	-2.0700
2 ■	-0.4453	-0.2558	1.2653	0.2890	-0.2557	-0.0651	-0.2742	-0.4218	-0.8391	0.1341	-0.4045	0.5411	-0.5580	0.5147	0.7754
3 ■	0.1626	0.4462	0.1055	0.9170	0.2610	-0.7167	-0.5295	0.0521	-0.6173	-0.4937	0.5348	0.3536	-0.9465	-0.3296	0.8004
4 ■	1.0486	0.2200	-0.0737	1.3826	-0.6698	0.2271	0.3967	-1.5223	-0.4530	-0.4856	0.6533	0.3846	0.0337	0.9397	-2.0820
5 ■	1.0920	-0.7130	-1.4439	0.4109	-1.3448	-2.0859	1.6970	0.6334	-1.8910	-2.3068	1.0410	0.8140	0.4991	2.3459	1.2521
6 ■	-0.1131	1.0459	2.6009	-0.3003	0.4081	-0.6211	0.0126	0.6633	1.1670	-3.1190	-1.4476	-0.1392	-1.3742	-0.1051	-0.0069
7 ■	-1.2047	1.6089	0.7322	-0.6137	0.0195	-0.3264	0.6405	0.9868	-0.1653	-0.0875	-1.5225	-0.6606	-0.2123	-0.1484	-0.7002
8 ■	-0.6186	2.2172	-0.0742	0.2494	0.9508	0.1350	-0.0880	0.3216	0.2214	-0.7264	-0.2492	-1.4324	-0.4921	0.5681	0.2729
9 ■	-0.3726	1.6728	-1.0366	0.0774	0.5487	1.3132	0.2147	0.8731	0.0061	0.4190	-0.9760	-1.3769	-2.1914	-0.3382	0.8640
10 ■	-0.3854	-1.2389	0.1061	0.7298	0.1284	0.1940	0.0907	0.1819	-0.2177	0.6273	-1.6436	-0.8239	-99.0000	2.1350	0.6816
12 ■	0.5705	0.6339	0.1841	0.1903	0.3842	-1.3984	-0.3353	-0.4932	-0.2686	0.8886	-0.6224	0.2663	-99.0000	-99.0000	-99.0000
13 ■	-0.1180	0.3180	-0.1864	0.3312	0.0666	-0.3189	-0.6929	-0.0671	0.3120	-0.1256	0.0412	0.4398	-99.0000	-99.0000	-99.0000
14 ■	-0.5753	0.2379	0.1119	0.1992	0.1269	0.0737	0.1122	-0.4350	-0.1267	0.2259	0.1735	-0.1242	-99.0000	-99.0000	-99.0000
15 ■	-0.2337	-0.0721	-0.1202	0.2829	-0.0802	0.0401	0.0383	0.0070	0.1032	-0.2590	0.1568	0.1370	-99.0000	-99.0000	-99.0000
17 ■	-0.6723	1.8469	0.0234	-1.0772	-0.6196	-0.0320	0.2731	0.3093	1.2115	0.1390	0.1935	0.6767	-0.4450	-1.5756	-0.2516
18 ■	-0.0235	0.1115	-0.2573	0.0860	-2.3712	-0.2066	-0.6776	0.3703	0.7179	0.6826	1.3266	0.3410	-0.2019	-0.1028	0.2050
19 ■	0.1156	-0.8083	-0.5021	0.1242	-0.4412	-1.8230	0.7897	-1.3238	0.8418	0.6237	1.0350	1.8820	-0.3675	0.7094	-0.8557
21 ■	0.4330	-0.0233	-1.9245	-3.4937	-2.4431	-1.4781	-0.7772	1.4358	1.1657	3.1205	0.9912	-0.0364	0.1563	3.6605	0.5422
** ■	-0.0386	0.4882	0.0724	-0.0739	-0.2882	-0.3635	0.0982	0.0232	0.0574	-0.0407	-0.0798	0.1076	-0.5201	0.5626	-0.0409

■ 1997*****

1 ■	-99.0000	0.0000
2 ■	-99.0000	0.0000
3 ■	-99.0000	0.0000
4 ■	-99.0000	0.0000
5 ■	-99.0000	0.0000
6 ■	1.3288	0.0000
7 ■	1.6538	0.0000
8 ■	-1.2558	0.0000
9 ■	0.3027	0.0000
10 ■	-0.5653	0.0000
12 ■	-99.0000	0.0000
13 ■	-99.0000	0.0000
14 ■	-99.0000	0.0000
15 ■	-99.0000	0.0000
17 ■	-99.0000	0.0000
18 ■	-99.0000	0.0000
19 ■	-99.0000	0.0000
21 ■	-1.3288	0.0000
** ■	0.0226	0.0000

-99 in the above table indicates a missing value

Percent of total sum of squares by index & yr; with row/column sums

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997*****	
1 ■	0.17	0.99	1.34	0.52	0.01	0.12	0.32	0.55	0.01	0.00	0.21	0.20	0.18	0.07	1.79	-99.00	6.48
2 ■	0.08	0.03	0.67	0.03	0.03	0.00	0.03	0.07	0.29	0.01	0.07	0.12	0.13	0.11	0.25	-99.00	1.93
3 ■	0.01	0.08	0.00	0.35	0.03	0.21	0.12	0.00	0.16	0.10	0.12	0.05	0.37	0.05	0.27	-99.00	1.93
4 ■	0.46	0.02	0.00	0.80	0.19	0.02	0.07	0.97	0.09	0.10	0.18	0.06	0.00	0.37	1.81	-99.00	5.11
5 ■	0.50	0.21	0.87	0.07	0.75	1.81	1.20	0.17	1.49	2.22	0.45	0.28	0.10	2.29	0.65	-99.00	13.07
6 ■	0.01	0.46	2.82	0.04	0.07	0.16	0.00	0.18	0.57	4.05	0.87	0.01	0.79	0.00	0.00	0.74	10.76
7 ■	0.60	1.08	0.22	0.16	0.00	0.04	0.17	0.41	0.01	0.00	0.97	0.18	0.02	0.01	0.20	1.14	5.22
8 ■	0.16	2.05	0.00	0.03	0.38	0.01	0.00	0.04	0.02	0.22	0.03	0.85	0.10	0.13	0.03	0.66	4.71
9 ■	0.06	1.17	0.45	0.00	0.13	0.72	0.02	0.32	0.00	0.07	0.40	0.79	2.00	0.05	0.31	0.04	6.51
10 ■	0.06	0.64	0.00	0.22	0.01	0.02	0.00	0.01	0.02	0.16	1.13	0.28	-99.00	1.90	0.19	0.13	4.79
12 ■	0.14	0.17	0.01	0.02	0.06	0.81	0.05	0.10	0.03	0.33	0.16	0.03	-99.00	-99.00	-99.00	-99.00	1.91
13 ■	0.01	0.04	0.01	0.05	0.00	0.04	0.20	0.00	0.04	0.01	0.00	0.08	-99.00	-99.00	-99.00	-99.00	0.48
14 ■	0.14	0.02	0.01	0.02	0.01	0.00	0.01	0.08	0.01	0.02	0.01	0.01	-99.00	-99.00	-99.00	-99.00	0.32
15 ■	0.02	0.00	0.01	0.03	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.01	-99.00	-99.00	-99.00	-99.00	0.12
17 ■	0.19	1.42	0.00	0.48	0.16	0.00	0.03	0.04	0.61	0.01	0.02	0.19	0.08	1.03	0.03	-99.00	4.29
18 ■	0.00	0.01	0.03	0.00	2.34	0.02	0.19	0.06	0.21	0.19	0.73	0.05	0.02	0.00	0.02	-99.00	3.87
19 ■	0.01	0.27	0.11	0.01	0.08	1.38	0.26	0.73	0.30	0.16	0.45	1.48	0.06	0.21	0.31	-99.00	5.80
21 ■	0.08	0.00	1.54	5.09	2.49	0.91	0.25	0.86	0.57	4.06	0.41	0.00	0.01	5.58	0.12	0.74	22.70
** ■	2.69	8.65	8.09	7.90	6.73	6.29	2.92	4.59	4.42	11.74	6.21	4.67	3.86	11.81	5.97	3.44	100.00

-99 in the above table indicates a missing value

Partial variance (and proportion of total) by index

	1	2	3	4	5	6	7	8	9	10	12	13
** ■	0.43648584	0.12984237	0.12974652	0.34445032	0.87997285	0.67544619	0.32760645	0.29573056	0.40881808	0.32232041	0.16434685	0.04160722
** ■	0.06653866	0.01979340	0.01977878	0.05250860	0.13414458	0.10296619	0.04994089	0.04508168	0.06232094	0.04913508	0.02505332	0.00634268
■	14	15	17	18	19	21*****						
** ■	0.02785962	0.01023215	0.28919056	0.26094604	0.39032384	1.42495768	6.55988354					
** ■	0.00424697	0.00155981	0.04408471	0.03977907	0.05950164	0.21722301	1.00000000					

STOCK NUMBERS (Jan 1) in thousands - GMCO97

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
1 ■	6162	5534	7746	4913	7410	9954	21645	3373	3391	5847	5294	7758	3753	1177	881	0
2 ■	9108	5018	4530	6339	4023	6067	8148	17721	2761	2776	4787	4334	6352	3073	964	721
3 ■	4328	6208	3325	3306	4821	3218	4772	6526	14204	2075	1961	3636	3480	5174	2319	730
4 ■	2666	2066	2950	1600	1399	1989	2096	2601	3911	8530	854	1126	1631	1930	3440	1370
5 ■	1661	1149	734	1058	413	410	625	854	814	1334	3219	261	342	309	537	1244
6 ■	166	787	363	206	296	112	85	145	293	277	322	810	97	20	77	125
7 ■	547	284	250	214	156	132	58	98	182	151	131	63	113	54	17	27
1+■	24639	21046	19900	17636	18518	21881	37428	31318	25555	20990	16569	17988	15769	11737	8234	4218

Summaries for ages 2 5 3 5 4 5 5 5

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
2 ■	17763	14441	11539	12302	10656	11683	15640	27702	21690	14716	10821	9358	11805	10486	7259	4065
3 ■	8656	9423	7009	5964	6634	5617	7493	9981	18929	11940	6035	5023	5453	7413	6296	3344
4 ■	4327	3215	3684	2658	1812	2399	2721	3455	4724	9864	4073	1388	1973	2238	3977	2614
5 ■	1661	1149	734	1058	413	410	625	854	814	1334	3219	261	342	309	537	1244

FISHING MORTALITY - GMCOD97

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1 ■	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2 ■	0.18	0.21	0.12	0.07	0.02	0.04	0.02	0.02	0.09	0.15	0.08	0.02	0.01	0.08	0.08
3 ■	0.54	0.54	0.53	0.66	0.69	0.23	0.41	0.31	0.31	0.69	0.35	0.60	0.39	0.21	0.33
4 ■	0.64	0.83	0.83	1.15	1.03	0.96	0.70	0.96	0.88	0.77	0.98	0.99	1.47	1.08	0.82
5 ■	0.55	0.95	1.07	1.07	1.10	1.37	1.26	0.87	0.88	1.22	1.18	0.79	2.66	1.19	1.25
6 ■	0.61	0.90	0.89	1.16	1.08	1.05	0.82	0.97	0.90	0.84	1.18	0.98	1.71	1.13	1.04
7 ■	0.61	0.90	0.89	1.16	1.08	1.05	0.82	0.97	0.90	0.84	1.18	0.98	1.71	1.13	1.04

Avg F for ages 2 5 3 5 4 5 5,5

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
2 ■	0.48	0.64	0.64	0.74	0.71	0.65	0.60	0.54	0.54	0.71	0.65	0.60	1.13	0.64	0.62
3 ■	0.58	0.78	0.81	0.96	0.94	0.85	0.79	0.71	0.69	0.89	0.84	0.79	1.51	0.82	0.80
4 ■	0.59	0.89	0.95	1.11	1.07	1.17	0.98	0.92	0.88	1.00	1.08	0.89	2.06	1.13	1.04
5 ■	0.55	0.95	1.07	1.07	1.10	1.37	1.26	0.87	0.88	1.22	1.18	0.79	2.66	1.19	1.25

Avg F (weighted by N) for ages 2 5 3 5 4 5 5,5

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
2 ■	0.37	0.50	0.48	0.46	0.50	0.30	0.28	0.20	0.40	0.68	0.53	0.38	0.40	0.36	0.59
3 ■	0.57	0.66	0.71	0.87	0.78	0.57	0.56	0.53	0.45	0.81	0.88	0.70	0.85	0.48	0.67
4 ■	0.61	0.88	0.87	1.12	1.05	1.03	0.83	0.94	0.88	0.83	1.14	0.95	1.67	1.09	0.88
5 ■	0.55	0.95	1.07	1.07	1.10	1.37	1.26	0.87	0.88	1.22	1.18	0.79	2.66	1.19	1.25

Avg F (wt by catch) for ages 2 5 3 5 4 5 5,5

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
2 ■	0.46	0.60	0.67	0.81	0.78	0.72	0.60	0.60	0.53	0.79	0.92	0.70	1.14	0.69	0.75
3 ■	0.58	0.68	0.74	0.90	0.80	0.80	0.63	0.66	0.55	0.82	1.00	0.72	1.16	0.74	0.77
4 ■	0.61	0.88	0.88	1.12	1.05	1.04	0.87	0.94	0.88	0.85	1.14	0.96	1.71	1.10	0.89
5 ■	0.55	0.95	1.07	1.07	1.10	1.37	1.26	0.87	0.88	1.22	1.18	0.79	2.66	1.19	1.25

BACKCALCULATED PARTIAL RECRUITMENT

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.29	0.22	0.11	0.06	0.02	0.03	0.02	0.02	0.10	0.12	0.06	0.02	0.00	0.07	0.06
3	0.84	0.57	0.50	0.57	0.62	0.17	0.32	0.32	0.34	0.56	0.30	0.61	0.15	0.18	0.26
4	1.00	0.88	0.77	0.99	0.93	0.70	0.55	1.00	0.97	0.63	1.00	0.55	0.91	0.65	
5	0.85	1.00	1.00	0.92	1.00	1.00	0.90	0.98	1.00	1.00	0.80	1.00	1.00	1.00	
6	0.96	0.94	0.83	1.00	0.98	0.76	0.65	1.00	1.00	0.69	1.00	0.99	0.64	0.96	0.83
7	0.96	0.94	0.83	1.00	0.98	0.76	0.65	1.00	1.00	0.69	1.00	0.99	0.64	0.96	0.83

MEAN BIOMASS (MT)

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	5013	4514	6317	4008	6044	8118	17656	2751	2766	4769	4318	6329	3062	960	719
2	8746	4788	4504	6987	4701	7081	9265	19825	2573	2650	6416	5032	8328	4424	1420
3	5090	7269	3938	3871	5877	4407	6729	9070	18827	2157	2894	4725	5108	8161	3851
4	4981	3186	5021	2490	2355	3869	3355	4604	5441	13690	1358	1654	2503	3021	5130
5	5582	2577	1528	2672	1067	997	1696	2025	2125	2946	5343	723	388	858	1032
6	766	2849	1303	621	1013	437	360	416	1358	1257	874	2937	266	90	326
7	4235	1685	1552	1142	901	776	420	706	1513	1071	756	407	505	389	113
1+	34414	26868	24163	21791	21958	25685	39481	39397	34602	28541	21958	21806	20159	17903	12590

Summaries for ages 2 5 3 5 4 5 5 5

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
2	24399	17820	14990	16021	13999	16354	21045	35524	28966	21443	16010	12133	16327	16464	11433
3	15654	13032	10486	9034	9298	9273	11780	15699	26393	18793	9595	7101	7999	12040	10013
4	10563	5763	6548	5162	3421	4866	5051	6629	7566	16636	6701	2377	2891	3879	6162
5	5582	2577	1528	2672	1067	997	1696	2025	2125	2946	5343	723	388	858	1032

CATCH BIOMASS (MT)

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
1	27	0	4	0	0	2	0	0	0	0	0	0	0	0	0
2	1603	1013	519	514	110	284	203	421	220	390	481	98	42	361	110
3	2746	3955	2093	2555	4027	1007	2737	2831	5835	1484	1026	2842	1990	1699	1256
4	3198	2659	4144	2872	2421	3704	2343	4428	4763	10604	1337	1640	3667	3262	4192
5	3052	2452	1638	2868	1178	1370	2144	1763	1864	3596	6307	570	1033	1019	1294
6	471	2557	1163	722	1095	459	295	402	1220	1062	1031	2872	454	101	338
7	2601	1512	1385	1328	973	815	345	682	1359	904	892	398	862	441	117
1+	13698	14149	10945	10859	9803	7642	8068	10526	15261	18040	11074	8420	8049	6883	7307

	Summaries for ages 2 5 3 5 4 5 5 5																
	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996		
2 ■	10599	10079	8393	8809	7735	6366	7427	9443	12681	16074	9151	5150	6733	6341	6852		
3 ■	8996	9066	7874	8295	7625	6082	7224	9022	12461	15683	8670	5052	6691	5979	6742		
4 ■	6250	5111	5782	5740	3598	5075	4487	6191	6627	14200	7644	2210	4701	4280	5486		
5 ■	3052	2452	1638	2868	1178	1370	2144	1763	1864	3596	6307	570	1033	1019	1294		
SSB AT THE START OF THE SPAWNING SEASON - males & females (MT)																	
	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996		
1 ■	330	297	399	142	214	292	640	108	237	351	346	479	217	67	50		
2 ■	2143	1247	1141	3096	2015	3041	4026	8685	620	634	1289	1082	1683	858	272		
3 ■	3185	4634	2503	3871	6012	4217	6438	8542	10234	1252	1423	2923	2700	4357	2155		
4 ■	4820	3105	4650	2781	2575	4028	3647	5085	5317	12109	1171	1644	2442	2932	5025		
5 ■	6070	2972	1738	2983	1204	1184	2017	2187	2284	3033	6666	716	587	927	1259		
6 ■	823	3496	1429	739	1245	511	409	597	1298	1274	1141	2834	358	82	379		
7 ■	5405	2311	2127	1666	1290	1103	566	985	2076	1451	1107	570	822	564	159		
1+■	22775	18062	13988	15277	14557	14377	17744	26188	22067	20104	13144	10248	8810	9786	9299		

The above SSBs by age (a) and year (y) are calculated following the algorithm used in the NEFSC projection program, i.e.

$$SSB(a,y) = W(a,y) \times P(a,y) \times N(a,y) \times \exp[-Z(a,y)]$$

where $Z(a,y) = 0.1667 \times M(a,y) + 0.1667 \times F(a,y)$

$N(a,y)$ - Jan 1 stock size estimates (males & females)

$P(a,y)$ - proportion mature (generally females)

$W(a,y)$ - weight at age at the beginning of the spawning season

The $W(a,y)$ are assumed to be the same as the Jan1 weight at age estimates (see "WT AT AGE" table in input section).

Jan1 weights at age are calculated as geometric means in ADAPT from the mid-year weight at age estimates (from the catch) of the cohort in successive years.

	MEAN STOCK NUMBERS (thousands) - GMCOD97																
	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996		
1 ■	5570	5015	7019	4453	6716	9021	19618	3057	3073	5299	4798	7032	3402	1067	798		
2 ■	7565	4113	3886	5545	3605	5393	7307	15898	2402	2345	4185	3891	5743	2678	842		
3 ■	3059	4379	2358	2217	3199	2617	3577	5107	11127	1375	1505	2501	2629	4248	1803		
4 ■	1802	1287	1845	877	806	1179	1383	1538	2396	5450	500	658	794	1088	2159		
5 ■	1170	682	415	598	231	206	328	524	498	712	1746	166	113	167	283		
6 ■	114	478	221	112	167	64	53	85	178	172	175	476	43	11	44		
7 ■	375	173	152	117	88	75	37	58	110	94	71	37	50	30	10		
1+■	19656	16128	15897	13920	14812	18555	32303	26268	19784	15448	12980	14761	12775	9290	5939		

Time stamp at end of run 1997 4 16 9 8 46

Appendix 4.

Precision estimates of the 1997 age-specific stock sizes, catchability coefficients, and 1996 instantaneous fishing mortality rates (F) and spawning stock biomass (SSB) for Gulf of Maine cod.

ADAPT ESTIMATE is from the final assessment run.

Standard errors, coefficients of variation (C.V.), and bias estimates are derived from 1000 bootstrap replications.

F on ages 4+ represents the fully-recruited portion of the stock.

BOOTSTRAP RESULTS FOR GMCOD97 Timestamp 1997 4 13 12 23 6
COD: GULF OF MAINE STOCK

SEED FOR THE RANDOM NUMBER GENERATOR: 74747
 MAIN LOOP LIMIT IN MARQUARDT ALGORITHM: 50
 NUMBER OF BOOTSTRAP REPLICATIONS ATTEMPTED: 1000
 NUMBER FOR WHICH NLLS CONVERGED: 1000

Results from the converged replications are used for computing the statistics that follow. Other replications are ignored.

Appendix 4:Table 1. BOOTSTRAP OUTPUT VARIABLE: N_hat
Age-specific stocksizes (on Jan 1, 1997) estimated by ADAPT

ADAPT ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN	
7.213E2	8.026E2	3.682E2	0.51	
7.303E2	7.543E2	2.199E2	0.30	
1.370E3	1.434E3	4.474E2	0.33	
1.244E3	1.320E3	4.977E2	0.40	
1.254E2	1.399E2	7.743E1	0.62	
BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	ADAPT EST CORRECTED FOR BIAS	C.V. FOR CORRECTED ESTIMATE
8.135E1	1.164E1	11.28	6.399E2	0.58
2.409E1	6.955E0	3.30	7.062E2	0.31
6.448E1	1.415E1	4.71	1.306E3	0.34
7.589E1	1.576E1	6.10	1.168E3	0.43
1.456E1	2.449E0	11.61	1.108E2	0.70

Appendix 4:Table 2. BOOTSTRAP OUTPUT VARIABLE: q_unscaled
Catchability estimates (q) for each index of abundance used in the ADAPT run. Note that these q's have been re-scaled to original units.

ADAPT ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN	
7.497E-5	7.587E-5	1.170E-5	0.16	
1.573E-4	1.585E-4	2.436E-5	0.15	
2.353E-4	2.363E-4	3.475E-5	0.15	
2.713E-4	2.738E-4	4.250E-5	0.16	
3.578E-4	3.591E-4	5.245E-5	0.15	
7.294E-5	7.350E-5	1.163E-5	0.16	
1.865E-4	1.888E-4	3.018E-5	0.16	
3.023E-4	3.076E-4	4.593E-5	0.15	
3.598E-4	3.648E-4	5.611E-5	0.16	
6.797E-4	6.848E-4	1.096E-4	0.16	
1.694E-5	1.715E-5	2.915E-6	0.17	
2.688E-5	2.727E-5	4.732E-6	0.18	
2.648E-5	2.707E-5	4.881E-6	0.18	
2.693E-5	2.738E-5	4.720E-6	0.18	
1.176E-3	1.190E-3	1.732E-4	0.15	
8.013E-4	8.140E-4	1.286E-4	0.16	
4.004E-4	4.049E-4	6.099E-5	0.15	
4.743E-4	4.758E-4	7.175E-5	0.15	
BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	ADAPT EST CORRECTED FOR BIAS	C.V. FOR CORRECTED ESTIMATE
8.949E-7	3.700E-7	1.19	7.408E-5	0.16
1.196E-6	7.705E-7	0.76	1.561E-4	0.16
1.058E-6	1.099E-6	0.45	2.342E-4	0.15
2.526E-6	1.344E-6	0.93	2.688E-4	0.16
1.304E-6	1.659E-6	0.36	3.565E-4	0.15
5.590E-7	3.679E-7	0.77	7.239E-5	0.16
2.319E-6	9.543E-7	1.24	1.842E-4	0.16
5.273E-6	1.452E-6	1.74	2.971E-4	0.15
5.054E-6	1.774E-6	1.40	3.547E-4	0.16
5.083E-6	3.467E-6	0.75	6.746E-4	0.16
2.090E-7	9.217E-8	1.23	1.673E-5	0.17
3.932E-7	1.496E-7	1.46	2.649E-5	0.18
5.943E-7	1.544E-7	2.24	2.588E-5	0.19
4.508E-7	1.493E-7	1.67	2.648E-5	0.18
1.337E-5	5.476E-6	1.14	1.163E-3	0.15
1.272E-5	4.067E-6	1.59	7.886E-4	0.16
4.491E-6	1.929E-6	1.12	3.959E-4	0.15
1.504E-6	2.269E-6	0.32	4.728E-4	0.15

Appendix 4:Table 3. BOOTSTRAP OUTPUT VARIABLE: N_t1

Full vector of age-specific stocksizes on Jan 1, 1997

ADAPT ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN	
4.894E3	4.910E3	1.920E2	0.04	
7.213E2	8.026E2	3.682E2	0.51	
7.303E2	7.543E2	2.199E2	0.30	
1.370E3	1.434E3	4.474E2	0.33	
1.244E3	1.320E3	4.977E2	0.40	
1.254E2	1.399E2	7.743E1	0.62	
2.730E1	2.780E1	9.673E0	0.35	
BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	ADAPT EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
1.601E1	6.070E0	0.33	4.878E3	0.04
8.135E1	1.164E1	11.28	6.399E2	0.58
2.409E1	6.955E0	3.30	7.062E2	0.31
6.448E1	1.415E1	4.71	1.306E3	0.34
7.589E1	1.574E1	6.10	1.168E3	0.43
1.456E1	2.449E0	11.61	1.108E2	0.70
5.004E-1	3.059E-1	1.83	2.680E1	0.36

Appendix 4:Table 4. BOOTSTRAP OUTPUT VARIABLE: F_t

Full vector of age-specific terminal F's (in 1996)

ADAPT ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN	
1.255E-6	1.358E-6	6.399E-7	0.51	
7.746E-2	8.129E-2	2.426E-2	0.31	
3.262E-1	3.369E-1	9.409E-2	0.29	
8.172E-1	8.470E-1	2.514E-1	0.31	
1.254E0	1.312E0	4.196E-1	0.33	
1.036E0	1.079E0	2.466E-1	0.24	
1.036E0	1.079E0	2.466E-1	0.24	
BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	ADAPT EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
1.032E-7	2.024E-8	8.23	1.151E-6	0.56
3.829E-3	7.672E-4	4.94	7.363E-2	0.33
1.068E-2	2.975E-3	3.27	3.155E-1	0.30
2.982E-2	7.950E-3	3.65	7.874E-1	0.32
5.766E-2	1.327E-2	4.60	1.196E0	0.35
4.374E-2	7.798E-3	4.22	9.919E-1	0.25
4.374E-2	7.798E-3	4.22	9.919E-1	0.25

Appendix 4:Table 5. BOOTSTRAP OUTPUT VARIABLE: F_full_t

Fully-recruited F in the terminal year (1996)

ADAPT ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN	
1.036E0	1.079E0	2.466E-1	0.24	
BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	NLLS EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
4.374E-2	7.798E-3	4.22	9.919E-1	0.25

Appendix 4:Table 6. BOOTSTRAP OUTPUT VARIABLE: SSB_spawn_t

SSB (males & females) at start of spawning season (1996)

ADAPT ESTIMATE	BOOTSTRAP MEAN	BOOTSTRAP STD ERROR	C.V. FOR NLLS SOLN	
9.300E3	9.585E3	1.337E3	0.14	
BIAS ESTIMATE	BIAS STD ERROR	PERCENT BIAS	ADAPT EST CORRECTED FOR BIAS	C.V FOR CORRECTED ESTIMATE
2.855E2	4.229E1	3.07	9.014E3	0.15